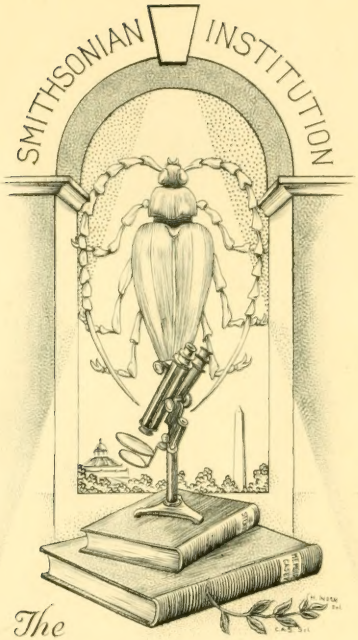


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OF THE

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OF

# LONDON.

THE

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OF

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## ERRATA.

### TRANSACTIONS.

Page 127, line 2 from bottom, for *Schirus* read *Schirus*.
Pages 477, 537, for *Belenogaster* read *Belonogaster*.
Page 679, line 14 from bottom, for *mennon* read *memnon*.
Page 681, line 18 from bottom, for *Letodes* read *Setodes*.
Page 717, line 18 from top, *for* makes *read* make.
Page 726, line 6 from top, *for* Tutts. *read* Tutt's.
Page 728, line 22 from top, for *Ceratochætu* read *Ceratochæta*.
Page 729, in Explanation of Plate, *for* Kamb. *read* Ramb

### PROCEEDINGS.

Page xli, line 13 from top, for *hanophyges durieuri* read *hanophyes durieui*.

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1877 Oberthür, René, *Rennes (Ille et Vilaine), France.*
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1897 Vice, William A., M.B., 19, *Belvoir-street, Leicester.*

1895 Wacher, Sidney, F.R.C.S., *Dane John, Canterbury.*
1901 Waddington, John, 38, *Leicester Grove, Blackman Lane, Leeds.*
1899 Wade, Albert, 20, *Frenchwood-street, Preston, Lancashire.*
1897 Wainwright, Colbran J., 2, *Handsworth Wood-road, Handsworth, Birmingham.*
1870 Walker, The Rev. Francis Augustus, D.D., F.L.S., *Dun Mallard, Cricklewood,* N.W.
1878 Walker, James J., R.N., F.L.S., H.M.S. "Ringarooma," *Sydney, Australia.*
1863 † Wallace, Alfred Russel, D.C.L., Oxon., F.R.S., F.L.S., F.Z.S., *Broadstone, Wimborne, Dorset.*
1866 † Walsingham, The Right Honble. Lord, M.A., LL.D., F.R.S., F.L.S., F.Z.S., High Steward of the University of Cambridge, *Merton Hall, Thetford* ; and 66*a*, *Eaton-square,* S.W.
1886 Warren, Wm., M.A., 61, *Wilton-avenue, Chiswick Lane,* W.
1869 Waterhouse, Charles O., *Ingleside, Avenue-gardens, Acton,* W. ; and *British Museum (Natural History), Cromwell-road,* S.W.
1901 Waterhouse, Gustavus A., B.Sc., F.C.S., *Waverley, Sydney, New South Wales, Australia.*
1900 Watkins, C. J., *King's Mill House, Painswick, Stroud, Gloucestershire.*
1893 Webb, John Cooper, 218, *Upland-road, Dulwich,* S.E.
1876 † Western, E. Young, 36, *Lancaster Gate, Hyde Park,* W.
1886 Wheeler, Francis D., M.A., LL.D., *Paragon House School, Norwich.*
1884 White, William, *Farnley, New Clive Road, Dulwich,* S.E.
1896 Wileman, A. E., c/o H.B.M.'s Consul, *Kobe, Japan.*
1894 Wilson, Edwin, *Mill-lane, Cambridge.*
1894 Wolley-Dod, F. H., *Millarville P. O., Alberta, N.W.T., Canada.*
1900 Wood, H., *The Old Grammar School, Ashford, Kent.*
1881 Wood, The Rev. Theodore, *The Vicarage, Lyford-road, Wandsworth Common,* S.W.
1901 Woodforde, F. C., *Market Drayton.*
1899 Woolley, H. S., 7, *Park-row, Greenwich,* S.E. ; and *P. O. Box* 1047, *Waterbury, Conn., U.S.A.*
1891 Wroughton, R. C., Inspector General of Forests, Indian Forest Service, *Simla, India* ; and c/o Army and Navy Co-operative Society, Ltd., 105, *Victoria-street,* S.W.

1888 Yerbury, Colonel John W., late R.A., F.Z.S., *Army and Navy Club, Pall Mall,* S.W.
1892 Youdale, William Henry, F.R.M.S., 29, *Daltonleigh, Cockermouth.*

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TRANSACTIONS

OF THE

# ENTOMOLOGICAL SOCIETY

OF

# LONDON

FOR THE YEAR 1902.

## I. *List of the Australian and Tasmanian* Mordellidæ, *with Descriptions of New Species.* By ARTHUR M. LEA, F.E.S.

[Read October 6th, 1901.]

PLATES I. and II.

As numerous additions have been made to this family since the publication of Masters' Catalogue, I have considered it advisable to preface the descriptions of a number of new forms with a list of the species hitherto recorded from Australia and Tasmania.

For some of the species additional localities are given, and a few previously referred to *Mordella* are now first placed in *Mordellistena* and *Tomoxia*. Several synonyms are also now first noted.

*Mordella æmula*, Lea.
„ *alboscutellata*, Lea.
„ *albosparsa*, Gemm. = *albosignata*, Boh.
„ *australis*, Boisd. *Hab.* W. A.
„ *baldiensis*, Blackb. *Hab.* W. A.
„ *bella*, Waterh. *Hab.* W. A.
„ *cara*, Blackb.
„ *caroli*, Lea = *waterhousei*, Lea, n. preoc.
„ *communis*, Waterh. *Hab.* W. A.; V.

*Mordella distincta*, Lea = *fulvonotata*, Champ., n. preoc.
„ *dumbrelli*, Lea. *Hab.* V.
„ *elegans*, Waterh.
„ *elongatula*, Macl.
„ *exilis*, Germ.
„ var. *obscurior*, Blackb.
„ var. *rufimanus*, Blackb.
„ *felix*, Waterh.
„ *festiva*, Lea.
„ *flavicans*, Macl.
„ *fugitiva*, Lea.
„ *fuscipilis*, Champ.
„ *graphiptera*, Champ. = *H. fasciata*, Lea. *Hab.* W. A.; V.
„ *hamatilis*, Macl.
„ *humeralis*, Waterh.
„ *ignota*, Lea.
„ *inusitata*, Blackb.
„ *lepida*, Redt.
„ *leucosticta*, Germ. = *abdominalis*, Bless. *Hab.* W. A.
„ *limbata*, Waterh.
„ var. w-*album*, Champ.
„ *mastersi*, Lea.
„ *multiguttata*, Waterh. *Hab.* Q.
„ *nigrans*, Macl.
„ *notabilis*, Macl.
„ *obscuripennis*, Macl.
„ 18-*maculata*, Lea. *Hab.* W. A.
„ 8-*maculata*, Macl.
„ *ornata*, Waterh.
„ *ovalisticta*, Macl.
„ *pallida*, Lea.
„ *parva*, Champ.
„ *promiscua*, Er.
„ *pulchra*, Lea.
„ *pulverulenta*, Macl. = *maculatissima*, Blackb.
„ *pygmæa*, Champ. = *uniformis*, Lea.
„ 14-*maculata*, Macl.
„ *raymondi*, Lea.
„ *ruficollis*, Waterh.
„ *rufipes*, Lea.
„ *subvittata*, Macl.
„ *sydneyana*, Blackb. *Hab.* V.

*Mordella tomentosa*, Boisd.
„ *tristis*, Lea.
„ *trivialis*, Waterh.
„ *undosa*, Macl.
„ v-*fasciata*, Lea.
„ var. *modesta*, Lea.
„ var. *venusta*, Lea.
„ *waterhousei*, Champ. = *obliqua*, Waterh., n. preoc.
„ *wiburdi*, Lea.
*Mordellistena aspersa*, Champ.
„ *austrina*, Champ. = *Mordella setipes*, Lea.
„ *brunneipennis*, Macl. (*Mordella*).*
„ *cuspidata*, Macl. (*Mordella*).
„ *fusca*, Lea (*Mordella*).
„ *jucunda*, Champ. = *Mordella longipes*, Lea.
*Tomoxia aterrima*, Macl. (*Mordella*).
„ *flavicans*, Waterh.
„ *laticeps*, Lea (*Mordella*).
„ 6-*lineata*, Lea (*Mordella*).

MORDELLA 8-MACULATA, Macl. (Plate II, figs. 28, 47.)

Mr. Champion † queries this species as being a synonym of *M. leucosticta;* it appears, however, to be sufficiently distinct, although allied to that insect. Compare figures 28 and 47 with 26, 27 and 48.

MORDELLA LIMBATA, Waterh. (Plate I, figs. 7, 8, 9.)

This is a widely distributed and very variable species; *M.* w-*album* is one of its varieties and possibly *M. promiscua* is another.

MORDELLA 18-MACULATA, Lea. (Plate II, figs. 30, 31, 49.)

A specimen from Western Australia under examination belongs to this species, but its elytral markings are very different to those of the type. On the prothorax, however, the unusual markings are identical.

* Mr. W. J. Rainbow kindly examined the type of this species at my request, and informed me that it has the apical hinder-part of the posterior tibiæ furnished with two ridges; it is, therefore, a *Mordellistena*, and is probably the *M. austrina* of Champion.

† Trans. Ent. Soc. Lond., 1895, p. 267.

Mordella graphiptera, Champ. (Plate I, figs. 3, 4.)

This species occurs in all the Australian colonies, and is somewhat variable. One specimen under examination has the markings reduced to five disconnected spots on each elytron.

Mordella australis, Boisd. (Plate I, fig. 12.)

The specimens I described (Proc. Linn. Soc. N.S.W., 1895, p. 288) as probably belonging to this species were sent to Mr. Champion for examination and returned by him as being "=*M. albosparsa*, Gemming." As, however, the specimens I described are typical of the species, and which can be recognized by means of my description, I have considered it advisable to refer to them as *M. australis*, in comparison with several forms described below. The species is common in Tasmania, besides New South Wales and Queensland.

Mordella baldiensis, Blackb.

From Geraldton and Rottnest Island (W. A.) I have numerous specimens that I cannot distinguish from this species; they are very closely allied to *M. fuscipilis*, but differ in possessing red, instead of black spurs.

Mordella v-aureum, n. sp. (Plate II, fig. 34.)

Black; anterior legs and posterior spurs reddish; basal joints of antennæ dull piceous-brown. Head and prothorax with golden-grey pubescence, the latter with an indistinct median and two lateral dark vittæ; elytra with black pubescence variegated with golden-grey as follows: along suture to near apex, three basal stripes of which the humeral one is most distinct, but joined to the median one, a median fascia irregular at each side, but forming a distinct median V, and two angular subapical spots almost conjoined. Under surface with greyish-white pubescence, variegated with large spots of black at the sides of abdomen.

Aculeus moderately long and rather thin, regularly decreasing in width, apex slightly obtuse. Posterior spurs unequal, the longest scarcely half the length of first tarsal joint.

Length 5 m.m.*

* The lengths given include the aculeus.

*Hab.* W. A.: Vasse.

The markings are very different to those of any other species with which I am acquainted, although the insect approaches some of the varieties of *M. bella.*

### Mordella obsoleta, n. sp. (Plate I, fig. 20.)

Black ; anterior legs, posterior spurs, muzzle and basal joints of antennæ reddish-testaceous. Pubescence purplish-black, on prothorax and head indistinctly variegated with white ; each elytron with an angular white median fascia : extending obliquely upwards from suture, then almost at a right angle downwards and then again upwards to suture ; near apex a white spot always largest near suture and frequently semilunar in shape. Under surface with silvery, variegated with black pubescence.

Aculeus moderately long, stout at base but strongly lessened from about middle, apex thin but truncate. Posterior spurs not quite equal in length, the longest fully half the length of first tarsal joint.

Length 4–4¾ m.m.

*Hab.* N. S. W.: Sydney.

In the five specimens under examination the elytra are entirely without basal markings, nor are any of the markings variable. The species approaches rather closely to some of the varieties of *M. bella,* but the spurs are very decidedly red.

### Mordella simillima, n. sp. (Plate II, fig. 32.)

Black ; anterior femora, posterior spurs and basal joints of antennæ reddish-testaceous. Head and prothorax with grey, golden-grey or golden pubescence ; the prothorax with a median and two lateral dark vittæ, which, however, are sometimes feeble or not at all traceable ; elytra with purplish-black pubescence, variegated with similar pubescence as on prothorax, and which is distributed on each as follows : along suture almost to apex, at base and on shoulder, between shoulder and suture a stripe (often conjoined with humeral pubescence and seldom distinctly separated from it), an angular median fascia which extends obliquely upwards from suture, then downwards and then upwards for a variable distance but never to margin, the third portion being sometimes entirely absent, a large subapical spot of variable size and shape but always concave internally and convex outwardly. Under surface with silvery or golden grey, variegated with black pubescence.

Aculeus rather short and stout, but apical two-fifths much narrower, apex truncate. Posterior spurs unequal, the longest more than half the length of the first tarsal joint.

Length 4½–6 m.m.

*Hab.* W. A.: Mount Barker (*Andrew Muir*), Garden and Rottnest Islands (*Lea*).

Very close in general appearance to *M. cara*.

### Mordella brevis, n. sp. (Plate II, fig. 33.)

Black; anterior legs, posterior spurs, muzzle, palpi and basal joints of antennæ reddish-testaceous. Head with greyish pubescence; prothorax with silvery pubescence, with a large median and two large lateral vittæ (these sometimes occupy almost the entire surface so that the white markings are entirely marginal); each elytron with white markings as follows: along base, where between side and suture a stripe (sometimes entirely disconnected) projects downwards; along suture to before middle, where it curves outwards and downwards, then upwards and then almost straight outwards to margin; near apex a large semilunar patch. Under surface with silvery and black pubescence.

Aculeus rather short and stout, but apical half much narrower than basal, apex obtuse. Posterior spurs unequal, the longest more than half the length of first tarsal joint.

Length 2½–3 m.m.

*Hab.* W. A.: Mount Barker (*R. Helms*), Bridgetown, Garden Island (*Lea*).

This species is rather close in general appearance to the one I have supposed to be *M. australis*, but it may be at once distinguished from that species by the shape of the median fascia and the absence of an oblique scutellar stripe. The markings are much more sharply defined in some specimens than in others, the basal stripe being especially liable to partial obliteration.

### Mordella cuneata, n. sp.

Black; legs (except the posterior femora and apex of tibiæ and tarsi, which are black) red; basal joints of antennæ obscure red. Uniformly clothed with greyish pubescence—no darker on the under than on the upper surface.

Aculeus not very long and stout, sides regularly diminishing in width to apex, which is obtusely rounded. Posterior spurs unequal, the longest less than half the length of the first tarsal joint.

Length 4½–6½ m.m.

*Hab.* W. A.: Pinjarrah.

A narrow species, in general appearance suggestive of a *Mordellistena*, but the posterior tibiæ and tarsi are of normal form. Numerous specimens were taken by means of the sweeping-net.

### Mordella verticordiæ, n. sp.

Black; densely clothed with grey, silvery-grey, golden-grey, or greyish-brown pubescence of an uniform shade on the upper surface, except that on the scutellum and suture it is almost white. Under surface and legs with greyish-white pubescence.

Aculeus rather short, sides strongly and not regularly decreasing in width to apex, which is finely but very distinctly emarginate. Posterior spurs decidedly unequal, the longest half the length of first tarsal joint.

Length $5\frac{1}{4}$–7 m.m.

*Hab.* W. A.: Mount Barker (*R. Helms*), Mogumber (*Lea*).

A very distinct species, on account of the emargination of the apex of the aculeus. In general appearance it is close to the preceding, except that the pubescence is denser. Numerous specimens were seen on the blossoms of various species of *Verticordia*.

### Mordella inornata, n. sp.

Black; base of antennæ and posterior spurs reddish-piceous. Pubescence black; on the head and front part of prothorax appearing greyish-brown in certain lights; on sides of sterna and abdominal segments with a silvery gloss in certain lights.

Aculeus long, thin and regular, apex very acute. Posterior spurs equal and less than half the length of first tarsal joint.

Length 9–$11\frac{1}{2}$ m.m.

*Hab.* N. S. W.: Victoria (*C. French*).

The largest black species hitherto recorded from Australia, and with a remarkably sharp aculeus. The pubescence from most directions appears to be entirely black.

### Mordella apicata, n. sp.

Black; upper surface densely clothed with greyish or reddish-brown pubescence, except on apical fifth of elytra, where it is black; sides of sterna, sides and middle of each of the abdominal segments, and base of aculeus, with greyish-white pubescence.

Aculeus moderately long, base stout and rapidly diminishing to near the tip, thence feebly diminishing to the apex, which is almost truncate. Posterior spurs almost equal and less than half the length of first tarsal joint.

Length 7 m.m.

*Hab.* Q.: Brisbane.

A rather robust species, that may be readily distinguished by the black apex of the elytra, the pubescence elsewhere on the upper surface is midway in colour between that of *M. exilis* and *M. inusitata*. The type specimen has been kindly presented to me by Mr. C. French, in whose collection it was unique.

### Mordella 9-maculata, n. sp.

Black; basal half of antennæ, posterior spurs, and anterior legs of a dingy red colour. Head with greyish-white pubescence; prothorax with black pubescence, but marked with white along the apex, base, sides, and on each side of middle; scutellum with silvery pubescence; each elytron with four distinct silvery spots: three close along the suture, nearly equal in size and at almost equal distances, the first slightly longer than wide, the second roughly rounded, and the third feebly transverse; the fourth spot is on the side midway between the first and second; each shoulder and the suture with a feeble sprinkling of greyish hairs. Sides and middle of sterna and abdominal segments and parts of legs with silvery pubescence.

Aculeus long and rather thin, but scarcely regular, apex somewhat acute. Posterior spurs almost equal and less than half the length of the first tarsal joint.

Length 8 m.m.

*Hab.* N. S. W.: Victoria (*C. French*).

A narrow species of medium size. The elytral markings are very distinctive, and at a glance appear to consist of three pairs of rounded spots. The clothing on the prothorax of the (two) specimens under observation appears to be somewhat abraded (quite possibly it should have been described as "white with a median and two lateral dark vittæ"). The white clothing of the scutellum causes the elytra to appear to be 9-spotted.

### Tomoxia maculicollis, n. sp.

Black; basal joints of antennæ dull red. Pubescence of a glossy purplish-black; head with greyish pubescence, parted in the middle;

apex of prothorax with an indistinct grey margin, across middle with four or six greyish-white spots (very distinct from some directions, but indistinct from others); scutellum, base of aculeus, sides and middle of basal segment of abdomen, and mesosternal episterna with silvery pubescence.

Aculeus short and stout, strongly diminishing in width to near apex, which is very decidedly truncate. Posterior spurs unequal, the longest less than half the length of the first tarsal joint.

Length 5–8 m.m.

*Hab.* W. A.: Pinjarrah.

Closely allied to *T. aterrima*, but the clothing of the upper surface is not entirely uniform.

MORDELLISTENA CONCOLOR, n. sp.

Piceous-black; posterior spurs testaceous. Clothing of an uniform and dingy greyish or brownish-black.

Aculeus long, thin and regular, the apex very acute. Posterior tibiæ with one feeble and two very distinct oblique ridges; spurs decidedly unequal in length, the longest less than half the length of first tarsal joint.

Length $3\frac{2}{3}$ m.m.

*Hab.* W. A.: Geraldton.

In appearance, except that it is narrower, remarkably close to *Mordella bulidensis*. It is the first black species of its genus to be recorded from Australia.

## Explanation of the Plates.

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### Plate I.

Right elytron of—

| FIG. | | |
|---|---|---|
| 1. 2. | *Mordella communis*, Waterh. | |
| 3. 4. | ,, | *graphiptera*, Champ. |
| 5. 6. | ,, | *bella*, Waterh. |
| 7. 8. 9. | ,, | *limbata*, Waterh. |
| 10. | ,, | *æmula*, Lea. |
| 11. | ,, | *festiva*, Lea. |
| 12. | ,, | *australis*, Boisd. |
| 13. | ,, | *dumbrelli*, Lea. |
| 14. | ,, | *multiguttata*, Waterh. |
| 15. | ,, | *cara*, Blackb. |
| 16. | ,, | *fugitiva*, Lea. |
| 17. | ,, | *felix*, Waterh. |
| 18. | ,, | *pulverulenta*, Macl. |
| 19. | ,, | *pulchra*, Lea. |
| 20. | ,, | *obsoleta*, n. sp. |
| 21. | ,, | *raymondi*, Lea |
| 22. | ,, | *trivialis*, Waterh. |
| 23. | ,, | *notabilis*, Macl. |
| 24. | ,, | *sydneyensis*, Blackb. |
| 25. | ,, | *ruficollis*, Waterh. |

### Plate II.

Right elytron of—

| FIG. | | |
|---|---|---|
| 26. 27. | *Mordella leucosticta*, Germ. | |
| 28. | ,, | 8-*maculata*, Macl. |
| 29. | ,, | 14-*maculata*, Macl. |
| 30. 31. | ,, | 18-*maculata*, Lea. |
| 32. | ,, | *simillima*, n. sp. |
| 33. | ,, | *brevis*, n. sp. |
| 34. | ,, | V-*aureum*, n. sp. |
| 35. | ,, | *caroli*, Lea. |
| 36. | ,, | *inusitata*, Blackb. |
| 37. 38. | ,, | *humeralis*, Waterh. |
| 39. | ,, | *venusta*, Lea. |
| 40. | ,, | *wiburdi*, Lea. |
| 41. | ,, | *distincta*, Lea. |
| 42. | *Mordellistena cuspidata*, Macl. | |
| 43. | *Mordella elongatula*, Macl. | |
| 44. | *Tomoxia* 6-*lineata*, Lea. | |
| 45. | ,, | *laticeps*, Lea. |

Prothorax of—

| | | |
|---|---|---|
| 46. | *Mordella* 14-*maculata*, Macl. | |
| 47. | ,, | 8-*maculata*, Macl. |
| 48. | ,, | *leucosticta*, Germ. |
| 49. | ,, | 18-*maculata*, Lea. |

## II. *The Life History of* Clythra quadri-punctata, L. By Horace St. John K. Donisthorpe, F.Z.S.

[Read December 4th, 1901.]

Plate III.

It is my intention to lay before you in this short paper an outline of the complete life history of *Clythra quadri-punctata*. A certain amount has been written upon the subject, but such writings are scattered and fragmentary, and in none is there a complete account of the creature's life history, nor has even what was known been connected together. I hope to fill up this blank in the life history of one of our common beetles. I have had all the stages under my close observation during the last two years, and have endeavoured not only to test and connect together what has been done already, but to find out and prove those facts which were unknown heretofore.

I give at the end of my paper a short sketch of what has been written before.

The two most important points which still required elucidating were how the larva gets into the ants' nest in which it is found, and on what it lives when there.

I commence my account of the life history from the point at which I myself began to study it, and this consisted of the larvæ and the larval cases taken from the ants' nests.

Now to carry on any experiments in this matter successfully, two things are necessary—a good supply of the larva, and a nest of its host, *Formica rufa*, in such a form that it can be under close observation and yet be as natural as possible. In order that much that follows may be understood, it becomes necessary for me to describe how I procured and arranged the latter of these requisites. In April I went to a nest of *Formica rufa* I had noticed at Oxshott. I found the ants "massing" on the hillock in the sun. I took a number of the workers, and about twelve queens, and several handfuls of the *débris* of the nest, and placed them all in a bag. On reaching home I placed the contents of the bag in a wooden box. I had

ready a large glass vessel, the bottom of which I had filled with mould. This vessel stood in a large zinc tray, the outside of which consists of a trough to hold water about an inch and a half wide, and two inches deep. Between the sides of the glass case and the trough there is space about two inches wide. The ants use a corner of this space as a cemetery and "kitchen midden," walking up the glass sides and returning with ease. I connected the vessel with a wooden box containing the ants, by means of a lead pipe. When as many of the ants as I required had passed through this tube into the glass case, I removed it, and placed a couple of handfuls of the *débris* out of the box on to the mould. The ants soon built up a small hillock in one corner of their case, and have steadily added to it ever since, excavating galleries beneath the mould. I have from time to time supplied them with fresh pine-needles, etc., to build with, and for food have given them honey and live insects.

If one digs deep into a nest of *Formica rufa* in the spring, one will generally find a lot of the curious cases made by the larva of *Clythra quadri-punctata*. This case, which is made of black excrementitious matter, is somewhat pear-shaped, and is open at the narrow end, the opening being closed by the hard horny head of the larva. On its upper side several ridges run from the mouth of the case, the inner ones meeting and forming a series of Vs, in order, as it is supposed, to strengthen it. On May 3rd this year I obtained a fair number of cases from a nest of *Formica rufa* at Weybridge, containing larvæ and pupæ. Some of these I proceeded to introduce into my "observation nest" described above. The ants attacked the cases, endeavouring to tear them open with their jaws (which are not however strong enough for this purpose), and squirted acid on to them. The closed cases (containing pupæ) were dragged about for a long time, but eventually most of them were taken into the nest.

When a case containing a larva was attacked, the larva withdrew into its case, blocking up the opening with its horny head. When it got the chance it laid hold of a twig or other object on the nest to prevent the ants dragging it about. When left alone it crawled stealthily along and finally disappeared into the nest. When walking the larva comes out of its case far enough to give free play to the legs, dragging the case after it.

I also removed some larvæ and pupæ from their cases and introduced them into my nest. These were attacked and torn to pieces by the ants. The naked larva is a fat, fleshy grub with a hard, horny head; it is much curved, and its hinder end, which is the largest part, is bent forwards, as in the *Lamellicornia.*

On May 4th I noticed a larva crawling about. I have in my notes, "It appeared to bite at the mould, fir-needles, etc."

On May 13th I introduced from the Blean Woods, where I had taken very many cases of all sizes in the ants' nest there, several pupal and larval cases. The same results were obtained. The ants carried some of them up the sides of the glass case, as if to remove them altogether. All the pupæ were in the end taken into the nest, or into some of the galleries underground; the larvæ entering the nest themselves.

On May 14th a larva was observed walking about, and on the 19th another was seen to come up out of a gallery and crawl about. The ants now paid no attention to it, walking over and by it. On June 16th I noticed an ant carrying a *Clythra* case with a larva in it. It took it out of the nest, and threw it into the water-trough. I put it back, but on the 17th it was again removed. I put it back for the second time, when it went down a gallery and was seen no more.

Having placed *Clythra* cases containing larvæ in small boxes with damp blotting-paper, I gave to some "egg-masses" of *Formica rufa,* to others dead ants and dead beetles, etc., from the nest. They none of them ever touched the "egg-masses" or any other animal matter supplied to them. They however sucked the wet blotting-paper. The largest larvæ (full-grown) closed their cases and pupated, but the smaller ones lived for months without growing, and in the end died. I placed others in boxes with mould and twigs, etc., from the nest. They appeared to bite at the refuse. Finally, to settle this question of food, I sent some full-grown fresh larvæ in spirit to Professor Poulton, who had kindly promised to dissect them for me under the microscope. He tells me he detected pieces of vegetable tissue after careful treatment, and that there is no doubt there was vegetable matter in the digestive tract. I also removed several larvæ from their cases, and put them into small boxes with the same different

sets of materials as the others, and I find that they are quite unable to construct a new case, when once they have been removed from their original one. They excrete small particles of a substance similar to that of which the case is made, but they never make any attempt to build a new case. These larvæ also lived for months; they were of all sizes, but the full-grown larvæ never pupated, and all died in the end.

I left cases in water, alcohol, benzine, methylated spirit, vinegar, sulphuric acid, etc., in all of which they are insoluble. The only thing in which they appear to be soluble is caustic potash. Furthermore I sent empty cases to Professor Poulton to experiment with. He kindly reports as follows: "Heated in the blue flame of a Bunsen burner, the cases first gave off a smoke and then burnt with a bright flame. This was probably the decomposition and removal of some cement substance and colouring matter secreted by the larva. Keeping the case at incandescence for some minutes, there remained a pale reddish-brown cast, exactly similar to the original case. It was friable, and easily ground to powder by pressure. This powder, examined in a drop of water under the microscope, was seen to consist of transparent crystalline masses of very variable size and irregular outline. They were unaffected by strong hydrochloric acid, and are probably minute fragments of quartz. The cases are probably made of an earth chiefly composed of a quartz sand, and cemented together by some secretion of the larva's. The reddish tint was probably caused by sesquioxide of iron, derived from iron in the earth made use of." These experiments confirm the fact that the larva constructs its case of earth, mixed with its excrement as a cement. We can see the importance of the cases being insoluble in acid since the ants squirt formic acid on to them.

Fabre says, speaking of species of *Cryptocephalus* and *Clythra*, that they enlarge the case by removing the old material from within, and plastering it on the outside, and that they construct the case with their excrement mixed with earthy material, using only the mandibles for the purpose. It is stated that when the larva changes its skin it first fastens its case to a piece of wood or other object in the nest. I have found that some of the larvæ in my nest fastened themselves to a small piece of wood for a day or two (when I thought they were going to pupate),

and then moved away again. To pupate, the larva, after closing the open end, or fastening it to something in the nest, turns round and faces the bottom of the case. The beetle emerges by cutting round the inside of the case in a circle with its mandibles, thus forming a cap, which it forces off.

We now come to my experiments with the perfect insect. On May 13th I introduced into my nest a beetle, which had hatched out from a case taken from a *Formica rufa* nest in the Blean Woods. It was attacked by the ants, dragged about, and later on thrown out of the nest half dead.

On May 16th a *Clythra* had emerged from the pupa-case in my nest; three ants were dragging about the empty case, and another the beetle, which remained quite motionless. From this date onwards many of the beetles kept emerging, both in my boxes and in my nest itself.

On May 18th a dead *Clythra* was removed from the nest by the ants; it had a hole bitten in its abdomen.

I find that when a *Clythra* emerges in the nest, it proceeds very cautiously to get away: remains quite motionless when attacked, "feigning death," and holding on to twigs etc.; when left alone it continues to walk again, and is generally successful in making good its escape.

Now it seemed to me that, as the beetle is so liable to be attacked by the ants, it would be very dangerous for the female, at such a critical time in the life history as the egg-laying, to return to the nest to deposit her eggs. The next question to settle therefore was how the larvæ got into the nest. In nature one finds the beetles flying round and settling on birch and other shrubs in districts where *Formica rufa* abounds. I placed some branches of birch in a jar of water in a large breeding-cage, and introduced all my beetles into it. They flew about in the sun, and very soon many couples were in copulation.

In copulation the ♂ sits far back on the ♀, all three pairs of tarsi resting on her elytra, the anterior pair just below the scutellum, intermediate pair on about the centre of each elytron, and the posterior pair two-thirds from the base of the elytra. The claws do not clasp hold, the tarsi holding on as if they were "suckers." The penis is fairly long and broad at the end, being somewhat spade-shaped. Copulation appears to take place many times, the same female being served by several males. I tried introducing couples in copulation on birch twigs into my nest;

they were, however, generally disturbed by the ants, when they separated and flew out of the nest. When not disturbed they separated in about twenty-five minutes, and then both flew away.

Last year I had eggs laid by these beetles, in boxes in which I had kept them. Nearly all the eggs were naked, but two of them were partly covered by a curious case. I sent them to Dr. Chapman to describe, as I was going away at the time; this he kindly did in the *Entomological Record* (for 1900, p. 213), as follows.

Of the naked eggs he says they were: "Long ovoid, apparently circular in cross-section. The length is ·12 m.m., the greatest width ·56 m.m. The colour is yellowish-white, somewhat opalescent, with clearer and more transparent contents towards the ends in some specimens."

Of the partly-covered eggs he writes: "When magnified so as to look an inch or two long, one cannot resist the idea that here is a larval case, or cocoon, clothed with the brown glumes, or bracts, that fall from the leaf-buds of trees when they open in the spring. The bracts are thin and membranous, projecting in various directions. . . .but unlike bracts, are not all to regular pattern, and are like irregular torn pieces of membrane, of various sizes and shapes. Their total projection is ·12 m.m. from the surface of the egg." He then asked if I could explain how this covering to the egg was provided, and what was its use. I suggested (*Entomologists' Record*, 1900, p. 238), that perhaps the beetles laid the eggs on, or in, the anthill, and that all the eggs were then supplied with capsules to serve the young larvæ as a protection till they had formed their own cases. Now let us return to the breeding-cage. I found that the beetles ate the leaves, and especially the young shoots of the birch, biting them through at the top.

On June 16th I found on the floor of the cage both covered and naked eggs, but in the case of the covered eggs they were now completely enveloped by such a capsule as that described by Dr. Chapman. They look exactly like the bract, or some other part, of a plant, and in fact are very like the end of a birch catkin when it breaks off. Without food the beetle does not appear to be able to construct a proper covering to the egg. This egg-case is made by the ♀ beetle from her own excrement. It is a lengthy process, which I was fortunate enough to observe on several occasions. The ♀ clasps a branch with

the anterior pair of legs, the body being held well away from it. The egg, which was held in the depression of the abdomen, is covered with excrement, which is smoothed, patted and arranged into the required shape by the posterior tarsi. When finished the egg is dropped. I obtained altogether a number of these covered eggs, as well as some naked ones, but they were always dropped to the ground. The ♀ does not appear to lay continuously, but to drop the eggs at intervals.

As Father Wasman records finding specimens at Exaeten, in Holland, "*die zur Eiablage die Nester besuchten*," I wrote and asked him if he had ever seen the ♀ laying. He replied as follows: "I have not seen the ♀ ♀ entering the nests, nor have I seen the act of oviposition. But I have found them sitting over the nest—for example, on grass stems overmounting the nests. I have also several times seen *Clythra*, freshly developed, attacked by the ants; they 'feigned death,' contracted their legs, and are probably protected also by their distasteful blood (the same as in *Timarcha*, whose secretion seems to be a means of defence, especially for many *Chrysomelidæ*). Relics of *Clythra* devoured by the ants I have even found in the nests." These remarks confirm my own observations. I may here record the experiments I carried out to prove the distastefulness, or otherwise, of this beetle. On June 9th I took a number of specimens of *Clythra quadri-punctata* to the Zoological Gardens, and offered them to the following creatures with the results recorded.

A white-backed trumpeter ate a *Clythra*, but it was evidently distasteful to it, and it refused to touch another. The other birds of the same species refused to eat any at all.

Some wood-swallows, after much pecking at and rejecting the beetles, eventually ate them; the keeper however said the birds were hungry, and the beetles were evidently not to their taste.

The lapwing pecked at *Clythra*, but eventually refused it, rubbing the beetle into the ground with its feet. It then went and washed its bill in some water.

The snow-bunting and house-sparrow both pecked at and killed *Clythra*, but refused to eat it.

The racket-tailed drongo was the only creature that ate *Clythra* readily, but this bird appears to eat anything that is given to it.

The marmosette took a *Clythra* from its keeper, and put

it into its mouth, but immediately took it out again, and threw it down in evident disgust. It would have nothing more to do with the beetles.

Finally my three species of lizards (*Lacerta viridis*, *Lacerta muralis* v. *tiliguerta*, and *Lacerta agilis*) would never touch *Clythra*.

In the *Entomologists' Record* (for 1900, p. 174) I stated that I considered *Clythra quadri-punctata* to be a mimic of the lady-bird, *Coccinella distincta*, which also lives in nests of *Formica rufa*; and in my paper on "Cases of Protective Resemblance, Mimicry, etc.," in our Transactions (Trans. Ent. Soc. Lond. 1901, part iii, p. 367), I suggested that *Clythra* might be distasteful on its own account, and thus provide an example of Müllerian mimicry. This we now see is the case.

To return to the covered eggs. We have seen that the ♀ beetle sits on a branch above, or near, a nest of *Formica rufa* and lets fall the egg. I therefore dropped and placed eggs into the case which contained my nest. They were always removed by the ants and taken into the nest. On June 23rd I placed a covered egg near my nest which I watched for some time. I have written in my note-book: "At 5.30 an ant took up the covered egg, and carried it into a gallery, returning immediately without it."

My experiments therefore have established this new and interesting point—that the ants carry the egg in its case into the nest. In carrying the egg into the nest, the ant may be under the impression that she has a bit of vegetable matter that will be useful in the nest, as other vegetable remains are; or she may think she has something different, but still a useful and normal addition to the nest. It seems highly probable that, were the beetle a pernicious and parasitic addition to the nest, the ants would ere this have learned to discriminate the egg as something undesirable. That she does take it in, under whichever of the impressions we have suggested, leads to the belief that the beetle is an inhabitant of the nest that is useful to the ants. In what way, we probably have no material for a conclusive opinion. It may be that its food is that portion of the vegetable material of the nest which has served its purpose to the ants, and which by incipient (or completed) decay is liable to be a danger to the community, or at least to clog the highways.

I kept some of the covered eggs in boxes, and bred some

of the young larvæ, which hatched in about twenty-one days. Dr. Chapman thus described a newly-hatched larva he bred from one of the eggs I sent to him last year: "The larva is very like a miniature cockchafer-grub in having the abdominal segments acutely bent forwards. The head is large, the antennæ short and stumpy, of two joints, the first so thick, and the second so square, at the end as to look like the two basal joints of a lepidopterous antennæ with the remainder broken off. The mouth-parts are well seen. The legs are very long, more than half the length of the body; the coxæ, femora, and tibiæ being very long; the tarsi are represented by a good claw only, which is however not a claw, but a joint, as it carries a hair or two."

When I before referred to the cases I took in the Blean Woods, I mentioned that I got them of all sizes. On the smallest cases I observed that the closed end was of a different material to the rest of the case; this on examination with the microscope turned out to be an egg-case. It is therefore evident that the egg-case fulfils several very important functions. First, to deceive the ants as to its real nature, and induce them to pick it up and take it into their nest, as they will any small vegetable substance, etc.; then, not only to protect the young larva from the ants, but to give it a foundation on which to commence the building of the larval case.

Fabre says that the egg-case (speaking of species of *Clythra* and *Cryptocephalus*) is covered over by the larval case, and may sometimes be found incrusted in it. This is not however my experience with *Clythra quadri-punctata*. I have found larval cases which were a little bigger than those just described, in which the egg-case had broken off, leaving a small hole. The hole is not large enough to be of any danger to the larva, and is soon filled up with the same material as the rest of the case.

To recapitulate the foregoing facts: The life history of *Clythra quadri-punctata* is briefly as follows. When the beetle has emerged from the pupa in the nest, it escapes with caution, "feigning death," and holding on to twigs, when attacked by the ants. It then seeks its mate, and copulation takes place. The beetles are generally to be found on birch shrubs, the young shoots and leaves of which they eat, biting the top shoots right through. The ♀ then seeks a tree or shrub above or close to a nest of *Formica rufa*, and

drops the eggs on to the ground beneath. The eggs are covered by a case, or capsule, which is placed around it by the ♀, and consists of her own excrement. This covering is placed in position with the posterior tarsi, the egg being held in the depression of the abdomen. The covered egg looks exactly like a small bract, and is exceedingly like the end of a birch catkin. The ants pick up the covered egg and carry it into the nest. The young larva, which hatches in about twenty-one days, uses the egg-case as a nucleus on which to build the larval case; thus very young larval cases have the egg-case still attached to their posterior end. The egg-case has a threefold *raison d'être*—to protect the egg and newly-hatched larva, to make the ants believe it is a bit of useful vegetable refuse, and to give the larva a foundation on which to start the larval case. When the larval case grows larger, the egg-case breaks off, and the larva fills up the hole thus formed with the same material as that with which it builds the rest of the case. This material consists of its own excrement mixed with earth, which it prepares with its mandibles. To enlarge the case the larva removes particles from the inside, and plasters them on to the outside. The larva feeds on vegetable refuse in the nest. When changing its skin it fastens the case to some object in the nest. When full-grown it fastens the case to a piece of wood or twig, and turning completely round, changes to a pupa, facing the broader end of the case. When hatched the beetle gets out of the case at this broader end, by biting a circle round inside it, thus forming a cap, which it forces off.

I now give as much of the bibliography as I have been able to find on the subject.

Schaller (Abhand. der Hall. Naturf. Gesellschaft, Bd. i, p. 328, 1783) points out that it is not only the larvæ of Lepidoptera and Neuroptera that make cases, but also coleopterous ones; and that a whole family of *Chrysomelidæ* have this habit. He then records having found ten cases containing larvæ under a stone; these cases and the larvæ he describes, and figures the former. He says, to pupate the larva turns round and faces the other end of its case. He mentions that *Chrysomela quadri-punctata* emerged from these cases, and that the food of the larvæ must be very different to that of the perfect insect.

Gené (Ann. des Sc. Natur., xx, pp. 143–156, 1830) relates

that the larvæ of *Clythra* and *Cryptocephalus* live in cylindrical tubes which they drag about with them. He describes the larva and case of a *Clythra*, explaining that the case is made of the excrement of the larvæ, which they place on with their mandibles. He mentions that the larva turns round in the case to pupate, and the beetle emerges through the broad end. He also points out that the ♀ covers the egg with her excrement.

A. Chevrolat (Revue Ent. Silbermann, iii, p. 265, 1835) records again finding in the centre of an ants' nest an isolated larva (coleopterous) which resembled that of *Clythra*. He describes this case, which he says is made of glutinous earth mixed with little stones, one end being closed by the head of the larva, which was smooth, black, and scaly.

Dr. Schmidt (Stet. Ent. Ztg., 1841, pp. 146–151), in a paper on *Clythra quadri-punctata* and its nearest allies, refers to Schaller's observations on the larvæ, mentioning that he has also had the opportunity to study them.

Maerkel (Germar. Zeitschr. f. Ent., iii, p. 221, 1841) describes the larval case of *Clythra quadrisignata*, many of which he had found in ants' nests. He mentions that the larva fastened up the open end of the case before pupation, and that the beetle came out at the other end. He then suggests that perhaps the larva of *Clythra quadri-punctata* does not live with ants.

Rosenhauer (Stet. Ent. Ztg., 1842, p. 50) records finding a *Clythra* case in a nest of *Formica rufa*, from which *Clythra 4-punctata* hatched out. He describes the case and larva, and says it must now be found out how the case is made, and what the larva feeds on.

Maerkel (Germar. Zeitschr. f. Ent., v, p. 254, 1844) states that according to Rosenhauer the larva of *Clythra quadri-punctata* lives in the nest of *Formica rufa*.

Lacordaire (Monog. des Coleopt. sub. de la Form. des Phytogapha, t. ii, p. 13, 1848) describes the larvæ, larval cases and egg-cases of *Clythra*. He states that the larval case is made of excrement, and not, as supposed heretofore, of earth. He mentions that the ♀ encloses the egg with her excrement. He suggests that when the larval case is closed, it is as a protection against the cold, and states that the larval case of *Clythra 4-punctata* has up to now only been found with *Formica rufa*.

Vallot (Revue Zoolog., ix, p. 180, 1848) describes *Clythra*

cases found in ants' nests, mentioning that the larva closes the case and turns round to pupate. He points out that what they feed on, and why they occur in ants' nests, is not known.

Rosenhauer (Ueber die Entro. und Fortpf. der *Clythra* and *Cryptocephalus*, 1852) describes the larva, pupa, larval case, and egg-case of *Clythra quadri-punctata*. He says the case is made of excrement, although the earlier writers have said it is made of earth. He points out that the larva of *Clythra quadri-punctata* is only found with *Formica rufa*. He records having found a closed case in the autumn, and suggests that the larva closes the case against the cold, as do snails. He found that the larva would not eat leaves or dead ants, but that it ate a meal-worm, and he expects they feed on the prey of the ants, but that it is very desirable that their real food should be found out. Speaking of species of *Clythra* and *Cryptocephalus*, he describes how the ♀ covers the egg which she drops, or throws away from her. He further states that when naked eggs occur, they are dropped by the ♀ against her will, or that she has not had food.

Chapuis et Candèze (Catalogue des Larves des Coleopt., p. 278, 1853) describe and figure the larva and larval case of *Clythra quadri-punctata*. They mention that the ♀ covers the egg with excrement, and that the larva enlarges the case by adding bits to it. They state that when it changes its skin, the larva first fastens up the end of the case.

Gabriel Tappes (L'Abeille, vol. iv, p. lxxxii) points out that the ♀♀ of *Cryptocephalus* have a small cavity on the last segments of the abdomen, and that they hold the egg in this cavity when, like *Clythra*, they cover it with excrement. He then describes how the ♀ carries out this operation, making the finished article look like buds or catkins. He mentions that the larva constructs another case, and that the first falls off, leaving only a slight trace at its lower end. He states that the larva is generally found in ants' nests, where it devours the twigs and bits of dried leaves collected by the ants. He also points out that the larval case is a protection against the ants. He mentions that the larva plasters on its case its excrement, which is seized by the legs, and that to pupate it closes the case and turns round. He says that to emerge the beetle cuts a cap off the bottom of the case.

F. Buchanan White (Scot. Nat., vol. i, p. 261, 1871) describes the larval case of *Clythra quadri-punctata*, which he says is of black excrementitious matter, and is constructed by the larva to protect itself from the ants. He also states that the larvæ (which he records as common in Scotland in the nests of *Formica rufa*) feed on the spongy material which forms the older part of the ant-hill, but he does not tell us on what grounds he makes this statement. He mentions that the larva fastens its case to a twig or other object in the nest to pupate, turning round and facing the bottom of the case.

Collett (Ent. Mo. Mag., xx, p. 40, 1883) records finding *Clythra quadri-punctata* in numbers near Hastings. They were flying in the sunshine around nests of *Formica rufa*, or sitting on bushes overhanging them. On several occasions he saw specimens crawling about with the ants, and once a ♀ emerging from the entrance to the subterranean cells.

Fabre (Souvenirs Entomologiques, Sept. Serre, pp. 235–259), writing on species of *Clythra* and *Cryptocephalus*, describes the larval cases, and says that of *Clythra* is insoluble in water, and fire has not much effect on it. In the flame of a candle it loses its brown colour, and takes on the tint of calcined ferruginous earth; hence the base must be of a mineral nature. He says the larva makes the case by bringing out of the back of it a pellet of excrement, which it kneads with a little earth, and plasters on with its mandibles. To enlarge the case it removes part of the inside and puts it on to the outside. He describes egg and egg-case (figuring the egg-case of *Clythra quadri-punctata*, which is not however very like it). He mentions that the ♀♀ let the eggs fall at intervals promiscuously from the boughs (one species of *Clythra* however fastening them by long filaments to a branch), and that the newly-hatched larva remains in the egg-case and adds to it to form the larval case. He says that the larvæ of *Clythra longipes* fed on bits of dead moistened bark, but that he believes they really ate the lichen and algæ that covered it, and not the bark itself. He makes no mention whatever of their connection with ants.

## Explanation of Plate III.

Fig. 1. The perfect insect.
2. The naked egg.
3. The covered egg, or egg-case.
4. The newly-hatched larva.
5. The full-grown larva.
6. The pupa.
7. The very young larval cases with egg-case attached, and after it has broken off.
8. The full-grown larval case.
9. Ditto (showing other side) attached to piece of wood.

## III. *Descriptions of New Australian Lepidoptera.*

By Edward Meyrick, B.A., F.Z.S.

[Read February 5th, 1902.]

The following genera and species of *Caradrinina*, accumulated from various collectors, appear to be undescribed; and as I am unable at present to deal with the group as a whole, it seems desirable to make them known without further delay.

### Caradrinidæ.

#### *Metopiora*, n. g.

Face forming a broad, rounded scaled prominence, terminating in a central truncate-cylindrical horny projection, surrounded by a sharp projecting horny ring. Eyes hairy. Tongue developed. Palpi moderate, subascending, loosely scaled, terminal joint short. Antennæ in ♂ subdentate, shortly ciliated. Thorax and abdomen without crests. Tibiæ with appressed hairs. Forewings normal. Hindwings: 3 and 4 stalked, 6 and 7 connate.

Allied to *Leucania*, from which it differs by the peculiar frontal projection.

#### *M. sanguinata*, Lucas.

(*Charielea sanguinata*, Lucas, Proc. Linn. Soc. N.S. Wales, 1892, 254.)

♂ ♀. 29–32 m.m. Head yellow-ochreous, mostly suffused with dull crimson. Thorax yellow-ochreous, patagia crimson-pink, except shoulders. Abdomen whitish-ochreous. Forewings elongate-triangular, costa gently arched, apex rounded, termen slightly sinuate, rather oblique; bright deep yellow; costal edge throughout and a costal streak from $\frac{2}{3}$ to apex crimson-pink; a moderate longitudinal slightly downwards-curved crimson-pink streak from base below middle to middle of termen; a crimson-pink terminal line, forming a small triangular spot at tornus: cilia crimson-pink, tips rosy-whitish. Hindwings pale whitish-ochreous; cilia ochreous-white.

Duaringa and Brisbane, Queensland (Barnard, Lucas).

*Heliothis codora*, n. sp.

♂. 28 m.m. Head dull pinkish, becoming whitish-ochreous at back of crown, face rounded-prominent. Palpi white, terminal joint pinkish. Thorax ochreous-whitish, pinkish-tinged. Tibiæ with few and weak spines, anterior tibiæ with two unequal strong horny apical hooks. Forewings elongate-triangular, costa slightly arched, apex obtuse, termen oblique, slightly rounded; a slight glandular swelling on middle of costa; reddish-ochreous, suffused with pale rosy-pink anteriorly and on veins, and with deeper rosy towards costa posteriorly; costal edge white throughout; a small thinly-scaled patch beneath costal swelling; an ochreous-whitish longitudinal median streak in disc from near base between veins 5 and 6 almost to termen, finely attenuated to extremities, and three or four fine ochreous-whitish streaks between veins posteriorly: cilia dull rosy-pink, tips of scales whitish. Hindwings white; veins and a broad suffused terminal fascia fuscous; cilia white.

New South Wales, probably Sydney; one specimen.

*Heliothis neuvias*, n. sp.

♀. 31 m.m. Head yellow-ochreous, face with rounded prominence. Thorax pale brownish-ochreous. Abdomen whitish-fuscous. Anterior tibiæ with two unequal strong horny apical hooks. Forewings elongate-triangular, costa almost straight, apex obtuse, termen slightly waved, bowed, oblique; whitish-ochreous, suffusedly mixed with pale ferruginous, especially along veins; veins fuscous, lower margin of cell most strongly; a moderate white longitudinal streak somewhat above middle from near base to near termen, extremities suffused and indistinct: cilia light fuscous, tips partly whitish. Hindwings fuscous-whitish, with a broad fuscous terminal suffusion; cilia white, basal half fuscous-tinged.

Port Darwin, North Australia (Lyell); one specimen.

*Hadena trichroma*, n. sp.

♀. 30 m.m. Head and thorax olive-greenish mixed with white and spotted with black. (Abdomen broken.) Forewings elongate-triangular, costa almost straight, apex obtuse, termen waved, bowed, rather oblique; light dull olive-green; a black spot on costa near base; an irregular black median mark from base; an oblique black dash from dorsum near base; first line thick, straight, white, followed by small black spots on costa and in middle; a very irregular blackish median shade, in which orbicular is absorbed; reniform

curved, transverse, white, preceded and followed by black spots, beneath connected by a curved white suffusion with a subquadrate blackish spot below middle connecting median and second lines; second line formed by a series of white lunules edged anteriorly with black, starting from a black spot on the costa above reniform, forming a strong double loop round reniform; slender waved-dentate white subterminal and terminal lines, confluent on upper third and connected in middle, space between them otherwise black. Hindwings rather dark-fuscous, somewhat whitish-suffused towards base, with darker discal spot.

Sydney, New South Wales, in June (Raynor); one specimen.

*Hadena iorrhoa*, n. sp.

♂. 42 m.m. Head and thorax brown-reddish irrorated with whitish-ochreous. Antennæ very shortly dentate. Abdomen light reddish-ochreous, very densely long-haired, with large supramedian crest preceded by two smaller ones. Femora clothed with very long dense hairs. Forewings elongate-triangular, costa almost straight, apex obtuse, termen waved, rather oblique, rounded; brown-reddish, irregularly sprinkled with whitish-ochreous, subbasal line pale, edged anteriorly with dark red-brown, apex connected with a dark red-brown dash in disc beyond it; first line indistinct, whitish-ochreous, dark-edged posteriorly; claviform dark-edged, semi-oval, resting on first line; orbicular large, oblique-transverse, dark-edged, lower anterior angle touching claviform; reniform quadrate, anteriorly dark-edged, posteriorly edged with whitish-ochreous, lower anterior angle confluent with orbicular; second line whitish-ochreous, indistinct, dentate, anteriorly dark-edged on lower half; subterminal distinct, whitish-ochreous, edged anteriorly with dark suffusion, with two prominent teeth on veins 3 and 4, lower reaching termen: cilia brown-reddish, with two cloudy dark brown lines. Hindwings reddish-fuscous; cilia pale reddish-ochreous, with a brown line, tips more whitish.

Tasmania (Simson); one specimen.

*Hadena andrias*, n. sp.

♂. 33 m.m. Head and thorax light brown sprinkled with whitish and blackish, collar with a blackish bar interrupted in middle. Antennæ very acutely bidentate (almost bipectinated). Abdomen whitish-grey-ochreous, with small subbasal crest. Forewings elongate-triangular, costa almost straight, apex obtuse, termen slightly waved,

rather oblique, rounded ; light brown, partially reddish-tinged ; subbasal line white, edged anteriorly and on costa posteriorly with blackish ; basal area mixed with white ; an undefined whitish streak, edged posteriorly with blackish irroration, from dorsum at ¼, nearly reaching middle of first line ; first line white, edged posteriorly with black, twice sinuate ; orbicular pear-shaped, oblique, pale yellow-ochreous, black-edged ; claviform absent ; reniform blackish-fuscous margined with pale yellow-ochreous, laterally black-edged ; space between reniform and orbicular white, connected by white suffusion with upper extremity of first line, and second line below middle ; subdorsal vein also white ; second line white, anteriorly black-edged, originating above reniform, forming a broad abrupt bisinuate loop round reniform, curved and broadly dilated towards dorsum ; subterminal line simple, white, preceded by some blackish-fuscous suffusion, especially in middle and towards costa, connected with second line near dorsum, and by a streak of whitish suffusion above middle ; a waved white terminal line enclosing a series of blackish-fuscous spots : cilia pale brownish with a dark fuscous line, barred with dark fuscous on apical half alternating with white. Hindwings white, with violet reflections ; veins and a moderate terminal fascia narrowed to a point at tornus fuscous, darker terminally ; cilia white, basally ochreous-tinged, with a series of faint fuscous spots.

Brisbane, Queensland (Lucas) ; one specimen.

## Plusiadæ.

### *Grammodes hoplitis*, n. sp.

♂. 32 m.m. Head, thorax, and abdomen light fuscous. Forewings somewhat elongate-triangular, costa almost straight, apex obtuse, termen waved, bowed, somewhat oblique ; light fuscous ; a dark brown trapezoidal patch occupying most of wing, resting on base and dorsum, its upper side near costa basally but gradually diverging, its posterior side near and parallel to termen, these two sides finely edged with white ; a moderate white diagonal streak from upper side near base to lower posterior angle ; a suffused dark fuscous oblique apical streak, faintly continued along edge of dark area : cilia light fuscous. Hindwings fuscous, paler towards base ; cilia light fuscous.

Duaringa, Queensland (Barnard) ; one specimen. There is an example from Fiji in the British Museum. Allied to *G. mygdon*, but the form of the dark patch is different.

*Thyas aellora*, n. sp.

♀. 58 m.m. Head, thorax, and abdomen light brownish. Posterior tibiæ spined. Forewings rather elongate-triangular, costa slightly sinuate, apex pointed, prominent; termen sinuate beneath apex, bowed, somewhat oblique; light fuscous, sprinkled with darker, and partially tinged with brown-reddish; first and second lines fine, pale, dark-edged, especially anteriorly, first straight, rather oblique, second obtusely angulated at $\frac{1}{3}$ from costa, thence moderately incurved, forming posterior edge of a rather dark fuscous band, very broad on costa and narrow on dorsum, its anterior edge straight and parallel to first line; a small dark fuscous subterminal spot opposite angle of second line. Hindwings dark fuscous, with pale hairs towards base; an undefined straight pale median line; a moderate pale fuscous terminal fascia, sprinkled with darker, from apex to tornus, narrowed to extremities.

Brisbane, Queensland (Lucas); one specimen.

*Thyas hercodes*, n. sp.

♂. 27 m.m. Head, thorax, and abdomen fuscous, whitish-sprinkled. Posterior tibiæ not spined. Forewings triangular, costa faintly sinuate, apex obtuse, termen waved, bowed, somewhat oblique; fuscous, darker-sprinkled, basal half irrorated with white; first and second lines slender, rather irregular, dark fuscous, nearly parallel, second with median third forming a right-angled projection outwards, on upper half edged posteriorly with white irroration; subterminal line obscurely dark fuscous, followed by some whitish scales: cilia fuscous, tips partially white. Hindwings fuscous, becoming blackish posteriorly; a whitish median line not nearly reaching costa; a fine whitish subterminal line on dorsal half; cilia dark fuscous, obscurely barred with whitish, with a white patch above middle of termen.

Duaringa, Queensland (Barnard); one specimen.

*Cryptsiprora*, n. g.

Face with strong conical horny prominence concealed in scales. Tongue developed. Palpi moderately long, ascending, second joint rough-scaled beneath, terminal joint moderate, cylindrical, obtuse. Thorax with expansible crest behind collar. Abdomen with strong crest near base. Femora densely hairy; tibiæ densely scaled, without spines. Forewings normal. Hindwings: 3, 4, 5 approximated, 6 and 7 approximated.

Allied to *Prorocopis*, but differing especially by the crested abdomen.

*C. ophiodesma*, n. sp.

♀. 27 m.m. Head and thorax fuscous sprinkled with whitish. Abdomen pale greyish-ochreous. Forewings elongate-triangular, costa almost straight, apex obtuse, termen strongly bowed, little oblique; fuscous, irregularly sprinkled with whitish; subbasal line black, irregular; first and second lines slender, black, irregular, first angulated near costa, median third forming an oblique rounded projection below middle, second from middle of costa to $\frac{2}{3}$ of dorsum, between $\frac{1}{5}$ and middle forming a very large sinuous expanded bilobed loop reaching to $\frac{4}{5}$ of wing, orbicular dot-like, black; reniform obscurely indicated by whitish irroration; a short thick oblique dark fuscous apical streak marked with black, preceded by a broad whitish suffusion towards costa; a terminal series of black dots: cilia fuscous sprinkled with whitish. Hindwings whitish-fuscous; a broad, rather dark fuscous terminal suffusion; cilia fuscous-whitish.

Geraldton, West Australia; one specimen in November.

*Eporectis*, n. g.

Face with short projecting tuft. Tongue developed. Palpi moderate, ascending, laterally compressed, second joint with dense loosely appressed scales, terminal joint short, truncate. Antennæ in ♂ bipectinated to near apex, pectinations terminating in long bristles. Thorax roughly scaled. Abdomen without crests. Anterior coxæ very long and projecting far in front of head, rough-scaled, femora with brush of dense rough scales beneath, tibiæ densely rough-scaled; middle and posterior tibiæ loosely scaled. Forewings normal. Hindwings: 3 and 4 closely approximated, 5 less approximated, 6 and 7 connate.

A singular genus without obvious affinities; the curious elongated anterior coxæ are, so far as I am aware, quite unique in the *Lepidoptera*.

*E. phenax*, n. sp.

♂. 25 m.m. Head, thorax and abdomen pale greyish-ochreous, somewhat brown-sprinkled. Forewings rather elongate-triangular, costa gently arched, apex obtuse, termen bowed, little oblique; rather light fuscous, with a faint ochreous tinge; costal edge suffusedly whitish from $\frac{1}{4}$ to $\frac{3}{4}$ and before apex; small dark fuscous costal spots at $\frac{1}{4}$, before middle, and at $\frac{2}{3}$: cilia ochreous-whitish, apical half barred with dark fuscous. Hindwings rather light fuscous; cilia

whitish-fuscous. Under surface of hindwings more whitish-tinged, mottled with dark fuscous.

Rosewood, Queensland; one specimen, attracted by light, in December. During flight the elongated anterior legs were projected in front of the head, giving a very peculiar appearance.

*Micræschus pyrrhantha*, n. sp.

♂. 15 m.m. Head and thorax reddish-ochreous. Abdomen whitish-yellowish sprinkled with reddish-ochreous. Forewings elongate-triangular, costa rather strongly arched posteriorly, apex obtuse, termen angulated on vein 4, concave on upper half, straight and oblique on lower half; dull reddish-ochreous, darkest in disc and towards costa; small whitish-yellowish triangular spots on costa before and beyond middle. Hindwings pale grey, suffused with pale reddish-ochreous, becoming whitish-yellowish anteriorly.

Sydney, New South Wales, in March; one specimen.

*Sophta*, Walk.

Face with conical horny scaled prominence. Palpi moderately long, porrected, second joint clothed with rough scales expanded towards apex above, terminal joint short, obtuse. Thorax and abdomen without crests. Forewings normal. Hindwings: 3 and 4 approximated, connate, or short-stalked, 5 rather approximated, 6 and 7 connate.

*S. omopis*, n. sp.

♀. 18 m.m. Head and thorax brown. Abdomen pale yellow-ochreous, base pinkish. Forewings elongate-triangular, costa sinuate, apex acute, termen concave on upper half, angularly prominent on vein 4, oblique and slightly concave below this; brown, towards termen whitish-fuscous; median area suffused with rosy-pink except towards costa, more broadly towards dorsum; costal edge blackish-mixed; first and second lines rising from white costal dots and pale yellow subcostal marks, first from ⅓ of costa, indicated by a few dark grey scales, slightly curved, second from before middle of costa, broken outwards beneath subcostal mark, thence slender, waved, irregular, whitish-grey, edged anteriorly with some black scales; an indistinct dark fuscous discal dot; three white dots on posterior half of costa; a præterminal series of black dots: cilia fuscous-crimson obscurely spotted with orange-ochreous, tips whitish except at apex and on median projection, where they are dark fuscous. Hindwings with termen bent on vein 7, thence nearly

straight; dull rosy-pink, costa whitish; first line nearly straight, dark grey; second somewhat irregular, whitish, followed by a broad darker band suffused with dark grey except towards dorsum; an interrupted blackish præterminal line; cilia orange-yellow, base pale crimson; tips whitish.

New South Wales (locality unrecorded); one specimen.

*S. acluropis*, n. sp.

♀. 21 m.m. Head, thorax, and abdomen brownish-ochreous, reddish-tinged. Forewings elongate-triangular, costa almost straight, apex subobtuse, termen rounded-prominent between veins 3 and 4, concave on upper portion, oblique on lower; ochreous-brown, slightly reddish-tinged, suffusedly mixed with dark fuscous, especially on veins and towards termen; orbicular represented by a white dot; reniform transverse-oval, ochreous, upper end edged with white, lower end forming a small clear white spot; extreme costal edge with about six ochreous-white marks: cilia dark red, tips white. Hindwings dark fuscous, somewhat lighter towards base.

Richmond River, New South Wales (Olliff); one specimen.

*Eublemma hemiplaca*, n. sp.

♂. 13 m.m. Head and thorax dark fuscous. Abdomen fuscous-whitish mixed with fuscous. Forewings elongate-triangular, apex obtuse, termen obliquely rounded; ochreous-white; basal half dark fuscous, limited by a slightly irregular line from just before middle of costa to just beyond middle of dorsum; a black discal dot at $\frac{3}{5}$; a narrow irregular fuscous terminal fascia; a terminal series of cloudy dark fuscous dots: cilia fuscous. Hindwings pale whitish-ochreous mixed with fuscous, posteriorly broadly fuscous.

Duaringa, Queensland (Barnard); one specimen.

*Eublemma leucodesma*, Low.

(*Thalpochares leucodesma*, Low, Proc. Linn. Soc. N.S.W., 1899, 88.)

♂ ♀. 13–14 m.m. Head and thorax whitish, whitish-ochreous, or reddish-ochreous. Abdomen orange-ochreous. Forewings elongate-triangular, apex obtuse, termen obliquely rounded; reddish-ochreous or ferruginous, sometimes whitish-mixed towards base, sometimes mixed with dark fuscous posteriorly; a rather broad whitish median fascia parallel to termen, more or less ochreous except on edges, sometimes partially or wholly suffused with dark grey except on anterior edge, anterior edge straight, posterior edge irregular with

strong abrupt projecting tooth in middle ; a broad streak of darker suffusion from apex to dorsum beyond this fascia, in one dark specimen obsolete : cilia whitish, mixed with reddish-ochreous. Hindwings whitish-yellow, becoming light ochreous-orange posteriorly, or sometimes mostly or wholly suffused with dark grey.

Duaringa and Brisbane, Queensland (Barnard); five specimens. Highly variable in colour, but always easy of recognition.

*Eublemma nymphodora*, n. sp.

♂. 11–12 m.m. Head, thorax, and abdomen white, partially ochreous-tinged. Forewings elongate-triangular, apex obtuse, termen obliquely rounded ; white, more or less suffusedly mixed with pale ochreous ; a brownish-ochreous streak along anterior half of costa ; a straight brownish-ochreous median fascia parallel to termen, anterior edge suffused, posterior edge sharply marked and followed by a clear white streak ; a black discal dot at $\frac{2}{3}$ ; second line fine, fuscous, indistinct, upper half forming a very strong loop outwards, below middle sinuate inwards ; area beyond this more or less suffused with brownish-ochreous ; an apical spot of blackish irroration, extending into costal cilia : cilia whitish, with two brownish-ochreous lines. Hindwings white, sometimes faintly greyish-tinged terminally ; a greyish terminal line ; cilia white.

Carnarvon, West Australia, in October; three specimens. Belongs to the group of *E. rosita*, but without rosy colouring, and specially characterized by the white hindwings.

*Eublemma marmaropa*, n. sp.

♂. 16–21 m.m. Head and thorax white, partially suffused with pale yellow. Forewings elongate-triangular, apex obtuse, termen obliquely rounded ; white, partly faintly yellowish-tinged ; a narrow pale brownish streak along anterior half of costa, edged beneath by a pale yellowish streak ; an elongate pale yellow spot near base in middle ; a straight pale yellow oblique fascia from beneath middle of costa to middle of dorsum ; a moderate ochreous-brown terminal fascia, paler terminally, narrowed to apex and tornus, anterior edge straight and edged with pale yellow suffusion, containing a series of cloudy grey-whitish præterminal spots between veins marked anteriorly with a few black scales : cilia white sprinkled with fuscous. Hindwings whitish, more or less yellowish-tinged posteriorly ; cilia whitish.

Port Moresby, New Guinea (Kowald) ; two specimens.

*Eublemma iothicta*, n. sp.

♀. 16 m.m. Head, thorax, and abdomen ochreous-whitish partially sprinkled with brownish-ochreous, head yellowish-tinged. Forewings rather elongate-triangular, apex obtuse, termen waved, bowed, rather oblique; fuscous-whitish, irregularly irrorated with fuscous and a few black scales; first and second lines formed of similar irroration, indistinct, curved, irregularly waved, second placed in a clear pale band limited anteriorly by a median shade which is acutely angulated above middle and marked with ferruginous between angle and dorsum; a transverse rather dark fuscous discal spot before median shade; a postsubterminal series of small indistinct spots of blackish irroration: cilia ochreous, basally ochreous-whitish. Hindwings as forewings, but first line and discal spot obsolete, median shade straight.

Port Moresby, New Guinea (Kowald); one specimen.

*Haplopscustis*, n. g.

Head with appressed scales. Tongue very short. Palpi moderate, porrected, with appressed scales, terminal joint short, obtuse. Antennæ in ♂ bipectinated to apex. Thorax crested posteriorly. Abdomen without crests. Legs with appressed scales. Forewings: 9 and 10 out of 8. Hindwings: 3 and 4 connate, 5 little approximated, 6 and 7 connate.

*H. erythrias*, n. sp.

♂. 17–18 m.m. Head and thorax ferruginous mixed with fuscous. Abdomen dark grey, base reddish-ochreous. Forewings triangular, apex obtuse, termen bowed, rather oblique; ferruginous or ferruginous-brown, more or less irrorated with dark fuscous, especially on median and præsubterminal bands; first and second lines thick, deep orange, rather irregular: cilia ferruginous, more or less mixed with dark fuscous. Hindwings dark fuscous, base suffused with yellow-ochreous; cilia ochreous-yellowish, sometimes mixed with dark fuscous and pinkish-tinged.

Port Darwin, North Australia (Lyell); Brisbane, Queensland (Lucas); in February: two specimens.

*Meranda*, Walk.

Head with appressed scales. Tongue developed. Palpi rather long, porrected, second joint clothed with long rough projecting scales above and beneath, terminal joint rather short, obtuse.

Antennæ in ♂ shortly ciliated. Thorax and abdomen without crests. Legs with appressed scales. Forewings normal. Hindwings: 3 and 4 connate, 5 little approximated, 6 and 7 short-stalked.

*M. holochrysa*, n. sp.

♂. 14 m.m. Head, palpi, and thorax orange. Abdomen pale orange. Forewings rather elongate-triangular, costa almost straight, apex obtuse, termen bowed, little oblique; light ochreous-orange; undefined irregular, rather thick, deeper orange transverse lines at $\frac{1}{3}$ and beyond middle; terminal area suffusedly darker: cilia light orange. Hindwings light orange, slightly infuscated.

Port Darwin, North Australia (Lyell); one specimen.

*Rivula ommatopis*, n. sp.

♂ ♀. 15-16 m.m. Head, thorax, and abdomen fuscous. Forewings elongate-triangular, apex obtuse, termen rather obliquely bowed; light fuscous mixed with darker; first and second lines faintly darker, but not distinctly traceable; a moderate roundish cloudy dark fuscous discal spot: cilia light fuscous mixed with darker. Hindwings fuscous, paler or whitish-tinged anteriorly; cilia pale fuscous.

Duaringa and Brisbane, Queensland (Barnard, Lucas), in September and May; three specimens.

*Ozarba*, Walk.

Face with short projecting tuft. Tongue developed. Palpi long, ascending, second joint broadly dilated with dense appressed scales, terminal joint long, slender, somewhat rough-scaled anteriorly, pointed. Antennæ in ♂ ciliated. Thorax and abdomen without crests. Legs with appressed scales. Forewings normal. Hindwings: 3 and 4 connate, 5 somewhat approximated, 6 and 7 connate.

*O. alopecodes*, n. sp.

♂ ♀. 20-22 m.m. Head and thorax pale fuscous. Abdomen pale ochreous-yellowish. Forewings somewhat elongate-triangular, apex rectangular, termen waved, bowed, rather oblique; whitish-ochreous or brownish-ochreous, tinged or sprinkled with pale reddish, sometimes suffused with light fuscous anteriorly and ferruginous posteriorly; a straight ferruginous shade from $\frac{3}{4}$ of costa to middle of dorsum, only distinct towards costa; two dark fuscous dots transversely placed in disc beyond middle; a faint darker fine subterminal

line ; a submarginal series of dark grey dots ; a ferruginous terminal streak : cilia reddish-ochreous mixed with ferruginous or reddish, with two cloudy blackish lines. Hindwings whitish-yellowish, in ♂ posteriorly reddish-tinged, with grey terminal shade, in ♀ suffused with rather dark fuscous ; cilia light reddish, base more or less suffused with dark grey.

Duaringa, Queensland (Barnard); two specimens.

*Oruza leptogramma*, n. sp.

♀. 15-18 m.m. Head and collar whitish-ochreous, thorax white. Abdomen whitish. Forewings somewhat elongate-triangular, apex rectangular, termen slightly waved, rounded, rather oblique ; white ; a whitish-ochreous transverse streak on dorsal half at about $\frac{1}{3}$ ; first and second lines thick, whitish-ochreous, curved outwards and less distinct on upper half, marked with a few black scales on costa ; moderate præsubterminal and præterminal whitish-ochreous fasciæ, indistinct towards costa ; orbicular represented by a blackish dot, reniform by two placed transversely ; sometimes a few black scales towards costa posteriorly ; a submarginal series of blackish dots : cilia whitish-ochreous, tips whitish. Hindwings as forewings, but with only one blackish discal dot.

Duaringa, Queensland (Barnard); three specimens.

*Essonistis*, n. g.

Head with appressed scales. Tongue developed. Palpi moderate, curved, ascending, second joint rough-scaled beneath, terminal joint short, slightly rough-scaled anteriorly, truncate. Thorax and abdomen without crests. Legs loosely scaled, femora slightly hairy. Forewings : 3 and 4 stalked, 7, 9, 10, 11 out of 8. Hindwings : 3 and 4 stalked, 5 tolerably parallel, 6 and 7 stalked.

*E. micræola*, n. sp.

♀. 12-13 m.m. Head and thorax white. Abdomen white mixed with light reddish and towards apex with blackish, second segment sometimes with distinct dark red band. Forewings elongate-triangular, costa hardly arched, apex rounded, termen obliquely rounded ; white sometimes sprinkled with fuscous ; six ochreous spots on costa, first three marked anteriorly with black ; indistinct traces of several ochreous transverse striæ ; first and second lines irregular, ochreous, sometimes partially fuscous, second abruptly sinuate inwards below middle ; a median spot of blackish suffusion

in disc; subterminal line indicated by irregular ochreous or fuscous marginal suffusions; a terminal series of small dark fuscous spots separated by ochreous: cilia pale ochreous irrorated with fuscous. Hindwings with colour, lines, terminal spots, and cilia as in forewings; a small black discal spot, in one specimen suffused with crimson-red; second line sometimes black.

Brisbane, Queensland (Lyell); two specimens.

*Trissernis*, n. g.

Head with appressed scales. Tongue developed. Palpi moderate, curved, subascending, second joint rough-scaled beneath, terminal joint rather short, obtuse. Thorax and abdomen without crests. Legs loosely scaled, femora with a few hairs. Forewings: 9 and 10 out of 8. Hindwings: 3 and 4 connate, 5 tolerably parallel, 6 and 7 short-stalked.

Nearly allied to *Arxeopterum*, Hamps.

*T. prasinoscia*, n. sp.

♀. 11 m.m. Head and thorax ochreous-white, partially greenish-tinged. Abdomen grey, two basal segments whitish, tinged with greenish, third reddish. Forewings elongate-triangular, costa almost straight, apex rounded, termen sinuate, oblique; light olive-green, irregularly irrorated with white; costal edge irregularly marked with black and ferruginous irroration; first and second lines indicated by series of small black dots, second starting from middle of costa very obliquely outwards on upper third; an irregular blackish spot in disc before middle; some grey suffusion posteriorly: cilia dark grey irrorated with whitish. Hindwings with colour and cilia as in forewings; some scattered black scales; a slender undefined blackish median line; some blackish suffusion towards costa and apex.

Brisbane, Queensland (Lyell); one specimen.

*Sandava xylistis*, n. sp.

♂ ♀. 24–29 m.m. Head and thorax pale whitish-ochreous, face with a dark red-brown band beneath antennæ. Antennæ in ♂ moderately ciliated. Abdomen pale whitish-ochreous, sprinkled with red-brown posteriorly. Forewings rather elongate-triangular, apex obtuse, termen waved, rounded, rather oblique; pale whitish-ochreous; subbasal line indicated by a dark red-brown costal dot; a small dark red-brown costal spot beyond this; first and second

lines very fine dark red-brown sprinkled with black, forming enlarged dots on costa, first right-angled posteriorly in middle, second curved, rather irregular, indented inwards above middle and towards dorsum; a small dark red-brown spot on costa before middle; orbicular represented by a cloudy ochreous dot, reniform by a small pale space surrounded by obscure ochreous suffusion; subterminal line pale, preceded by an indistinct light ochreous-brown shade, forming an enlarged dark red-brown spot on costa, and followed by a stronger ochreous-brown shade, with spots of dark red-brown suffusion in middle and on costa; a præterminal series of blackish marks: cilia pale whitish-ochreous, barred with red-brown. Hindwings with termen strongly waved; colour, second line, and cilia as in forewings; a straight blackish median line mixed with dark red; a transverse ochreous discal spot preceding this, connected with it at lower end; terminal area wholly dark red-brown on lower half, intersected by pale subterminal line.

Melbourne, Victoria (Kershaw, Lucas); three specimens.

*Sandava spilotis*, n. sp.

♂ ♀. 19–20 m.m. Head, thorax, and abdomen pale greyish-ochreous sprinkled with dark fuscous. Palpi shorter than in *S. xylistis*, thorax more roughly scaled. Antennæ in ♂ with long setæ. Forewings somewhat elongate-triangular, costa almost straight, apex obtuse, termen waved, rounded, rather oblique; whitish-ochreous, irrorated with dark fuscous; an undefined dark fuscous subbasal fascia, well-marked on costa; first and second lines dark fuscous, irregular, sometimes undefined, forming enlarged dark fuscous spots on costa, first nearly straight, second curved outwards, approximated to first dorsally; a transverse-oval dark fuscous discal spot; a rather large roundish dark fuscous spot beyond second line in middle; a more or less distinct suffused dark fuscous apical spot; a præterminal series of dark fuscous marks: cilia whitish-ochreous, mixed with fuscous. Hindwings with termen strongly waved, rounded; colour, first and second lines, discal spot, and cilia as in forewings, but lines obsolete costally.

Duaringa, Queensland (Barnard); two specimens.

*Paonidia*, n. g.

Forehead with projecting ridgelike tuft. Tongue developed. Antennæ in ♂ strongly ciliated. Palpi long, obliquely ascending, second joint rough-scaled above and beneath, terminal joint moderate, densely scaled, obtuse. Collar (in ♂ only ?) forming an expansible

mass of much enlarged flat scales. Abdomen without crest. Legs with appressed scales. Forewings with raised discal tuft ; neuration normal. Hindwings with raised discal tuft ; 3 and 4 short-stalked 5 tolerably parallel, 6 and 7 remote.

*P. pentaptila*, n. sp.

♂. 21 m.m. Head and thorax reddish-ochreous partially suffused with fuscous. Abdomen fuscous. Forewings elongate-triangular, costa hardly arched, apex obtuse, termen crenulate, rounded, oblique ; ochreous-brown, basal, discal, and dorsal areas largely suffused with dark purplish-fuscous ; an undefined ferruginous streak beneath costa from near base to beyond middle ; first and second lines waved, double, blackish, first slightly curved, second enclosing a whitish-ochreous costal mark, strongly curved outwards on upper $\frac{3}{4}$ ; an indistinct irregularly curved darker median shade : beyond second line a large subtriangular dark fuscous costal patch, somewhat glossy and greenish-tinged ; subterminal line indistinct, pale, waved, darker-edged ; a terminal series of dark fuscous dots between veins, connected by fuscous suffusion : cilia greyish-ochreous mixed with dark fuscous, base spotted with light brown. Hindwings with termen crenate, ochreous-brown, sprinkled with dark fuscous ; discal tuft larger than in forewings, scales partly pale ; median, second, and subterminal lines, terminal markings and cilia as in forewings, but second line less curved, without pale costal mark.

Richmond River, New South Wales (Olliff); one specimen.

*Trigonistis*, n. g.

Head with projecting frontal tuft. Tongue developed. Antennæ in ♂ bipectinated, apex simple. Labial palpi very long, second joint straight, porrected, clothed with rough scales diminishing towards apex, terminal joint moderate, slender, cylindrical, ascending. Thorax and abdomen without crests. Legs with appressed scales. Forewings : 9 and 10 out of 8. Hindwings : 3, 4, 5 approximated, 6 and 7 connate.

Type *T. demonias*. Closely allied to *Hypenodes*, but without abdominal crest.

*T. demonias*, n. sp.

♂. 16 m.m. Head and thorax whitish-ochreous suffused with whitish. Antennal pectinations long. Palpi abnormally long, second joint about ten times width of eye, terminal about half second. Fore-

wings elongate-triangular, costa moderately arched, apex subacute, termen slightly sinuate, rather oblique, rounded beneath; whitish-ochreous, partially suffused with whitish, with some scattered fuscous and dark fuscous scales; a rather large roundish dark fuscous discal spot; a subterminal series of small dark fuscous spots, terminating in a short oblique dark fuscous apical dash, the spot between veins 5 and 6 dash-like and placed nearer base; a terminal series of dark fuscous marks: cilia whitish-ochreous, sprinkled with fuscous. Hindwings dull whitish; a small fuscous discal spot; cilia whitish.

Brisbane, Queensland (Lucas); one specimen.

*T. asthenopa*, n. sp.

♂. 15–16 m.m. Head and thorax pale whitish-ochreous. Antennal pectinations moderate. Palpi about 5. Forewings elongate-triangular, costa sinuate, apex nearly rectangular, termen bowed, oblique, strongly sinuate on upper half; whitish-ochreous, strigulated with brownish-ochreous, with a few scattered black scales; costal edge yellowish on anterior half; a black subcostal dot near base; first line indicated by five irregularly placed blackish dots; two black discal dots transversely placed beyond middle; second line running from a black mark on middle of costa to $\frac{3}{5}$ of dorsum, ferruginous mixed with black, most strongly marked dorsally, upper $\frac{2}{3}$ forming a strong biangulated projection posteriorly; terminal area brownish-ochreous, enclosing a pale subterminal line; a series of small black spots along termen and posterior part of costa: cilia brownish-ochreous mixed with paler. Hindwings whitish, very faintly tinged with pinkish-grey; a small dark grey discal spot; an interrupted dark grey terminal line; cilia whitish, faintly pinkish-tinged.

Brisbane, Queensland (Raynor); Gosford, New South Wales (Lyell); in November, three specimens.

*Hypenodes porphyritica*, n. sp.

♀. 17 m.m. Head and thorax whitish-ochreous suffused with light brown-reddish. Palpi nearly 4. Abdomen fuscous, segmental margins ochreous-whitish, sides yellowish-mixed. Forewings elongate-triangular, costa faintly sinuate, apex obtuse, termen bowed, oblique; pale reddish-brown, thinly sprinkled with dark fuscous; costal edge ochreous-yellowish spotted with dark fuscous; subbasal, first, and second lines dark fuscous, ill-defined; first indented above and below middle, second strongly curved outwards from $\frac{1}{5}$ to below middle; median faint, brown, parallel to second, its curve surrounding

an indistinct brown discal spot; a triangular præsubterminal dark fuscous costal spot; subterminal line hardly paler; a series of indistinct dark fuscous terminal spots: cilia pale reddish-brown, sprinkled with dark fuscous. Hindwings rather dark fuscous, dorsally mixed with pale ochreous, with extremities of darker lines indicated; cilia pale ochreous mixed with dark fuscous.

Wirrabara, South Australia, in October; one specimen.

*Hypenodes micropa*, n. sp.

♂. 16–17 m.m. Head and thorax light brownish-ochreous, sometimes sprinkled with black. Antennæ ciliated. Palpi 3. Forewings elongate-triangular, costa slightly arched, apex nearly rectangular, termen bowed, oblique; brownish-ochreous suffused with light fuscous and sprinkled with dark fuscous; first line irregular, undefined, curved, dark fuscous; a transverse white discal dot at $\frac{3}{5}$, edged with dark fuscous; second line starting from a dark fuscous spot on costa, obscure, undefined, dark fuscous, angulated above middle; indications of an irregular dark fuscous præsubterminal shade; a terminal series of small dark fuscous spots: cilia pale ochreous irrorated with dark fuscous. Hindwings grey-whitish, sprinkled with grey posteriorly; a grey discal dot and faint postmedian line; cilia grey-whitish.

Brisbane, Queensland; Sydney, New South Wales; in October, three specimens.

*Rhynchina comias*, n. sp.

♂. 25 m.m. Head and thorax yellow-ochreous, sprinkled with brown, patagia loosely hairy. Antennæ rather strongly bipectinated, apical half simple. Terminal joint of palpi short, much thickened with scales. Abdomen yellow-ochreous, partially suffused with whitish. Forewings elongate-triangular, costa posteriorly moderately arched, apex very obtuse, termen oblique, slightly waved, rather angularly prominent on vein 4; yellow-ochreous, sprinkled with brown, towards costa with dark fuscous, especially towards base; subbasal line slender, white; first line about $\frac{1}{5}$, nearly straight, whitish, only distinct on costa and median vein; orbicular small, oval, clear white; median shade well-marked, rather dark fuscous, bent near costa; reniform represented by two transversely placed black dots, partially edged with white; second line irregular, faintly whitish, partially dark-edged anteriorly, very indistinct; subterminal indicated by a well-marked nearly straight ochreous-brown shade, followed by an irregular whitish shade finely sprinkled with

blackish, tending to be partially extended between veins to termen; an interrupted black terminal line: cilia ochreous, tips partially blackish-mixed, especially on median prominence. Hindwings with termen waved; colour and markings as in forewings, but (except posteriorly) much paler and partially suffused with prismatic-whitish, orbicular and preceding lines absent, median indistinct, an additional faint irregular shade between median and second lines.

New Guinea (Sayer); one specimen.

*Chaographis*, n. g.

Face with appressed scales. Tongue developed. Palpi moderate, porrected, second joint with loosely appressed scales, terminal short, obtuse. Thorax and abdomen without crests. Tibiæ smooth-scaled. Forewings normal. Hindwings: 3 and 4 connate, 5 parallel, 6 and 7 connate.

*C. crystallodes*, n. sp.

♀. 21–23 m.m. Head and thorax white sprinkled with fuscous. Abdomen whitish, sprinkled with ochreous. Forewings somewhat elongate-triangular, costa straight, apex obtuse, termen bowed, rather oblique; light brownish-ochreous, mixed with dark brown in disc; basal area mixed with white; first and second lines thick, cloudy, white, first straight, oblique, second from $\frac{1}{3}$ of costa to $\frac{2}{3}$ of dorsum, sinuate, sometimes distinctly double; orbicular white, narrow, very oblique; reniform large, 8-shaped, edged and mixed with white, lower half projecting anteriorly so as almost to touch orbicular; subterminal line represented by cloudy white subcostal, median, and subdorsal spots; an indistinct waved whitish terminal line. Hindwings whitish-fuscous, becoming fuscous terminally; cilia whitish-fuscous.

Duaringa, Queensland (Barnard); three specimens.

*Piratisca*, n. g.

Tongue developed. Palpi long, recurved, second joint with dense rough projecting scales beneath, diminishing to apex, terminal joint moderately long, acute, with long tuft of projecting scales in middle posteriorly. Femora rough-haired beneath. Forewings: 7 and 8 out of 9, 10 connate with 9. Hindwings: 3 and 4 connate, 5 closely approximated at base, 6 and 7 connate.

*P. minax*, n. sp.

♀. 51 m.m. Head and thorax fuscous mixed with dark fuscous. Forewings elongate-triangular, costa gently arched, apex rounded-

obtuse, termen waved, rounded, little oblique; purplish-fuscous mixed with dark fuscous; subbasal, first, and second lines waved-dentate, blackish, second about middle, curved outwards in disc; orbicular represented by a dot of raised pale yellowish scales; reniform by a dark fuscous suffusion preceded by two transversely placed similar dots; traces of a paler dentate line at $\frac{3}{4}$, followed by a spot of dark fuscous suffusion above middle; a terminal series of pale ochreous dots preceded by dark fuscous dashes: cilia fuscous. Hindwings and cilia brown.

New Guinea (Sayer); one specimen.

*Simplicia selenitis*, n. sp.

♂. 29 m.m. Head, thorax, and abdomen whitish-ochreous; antennæ without thickening; palpi clothed posteriorly with long loosely projecting scales on terminal joint and apex of second. Forewings elongate-triangular, apex obtuse, termen slightly waved, rounded, little oblique; light greyish-ochreous, obscurely sprinkled with fuscous; basal $\frac{2}{3}$ suffused with dark fuscous; first and second lines slender, fuscous, prominently angulated above middle and near dorsum, curved inwards between these; a bent transversely linear dark fuscous discal mark, interrupted in middle; a fuscous terminal band, broadest in middle, containing an inwards-curved slender whitish anteriorly darker-edged subterminal line, running from apex to tornus: cilia pale fuscous, with darker fuscous anterior shade and subapical line. Hindwings whitish-fuscous, somewhat darker posteriorly; an obscure whitish inwards-curved subterminal line from apex to $\frac{2}{3}$ of termen.

Brisbane, Queensland (Lucas); one specimen.

*Simplicia micrastis*, n. sp.

♂ ♀. 18–19 m.m. Head and thorax pale ochreous mixed with fuscous; antennæ without thickening; palpi clothed with loose rough scales posteriorly on terminal joint and apex of second. Forewings elongate-triangular, apex obtuse, termen bowed, rather oblique; pale ochreous tinged with brownish and irrorated with fuscous; first and second lines curved, fuscous, dotted with black, but ill-defined and indistinct; a moderate discal spot beyond middle, in ♂ dark fuscous, in ♀ outlined with dark fuscous, connected with dorsum by a straight cloudy dark fuscous median shade not extended to costa; terminal area suffused with fuscous, including a very indistinct pale sinuate interrupted subterminal line; a waved dark fuscous terminal line: cilia whitish-ochreous,

with three fuscous lines. Hindwings in ♂ whitish-fuscous, darker posteriorly; in ♀ whitish with light fuscous terminal band cut by pale subterminal line; a small faint fuscous discal spot; cilia as in forewings.

Brisbane, Queensland (Lucas); two specimens.

## Sarrothripidæ.

*Earias limonia*, n. sp.

♂. 26 m.m. Head and thorax whitish sprinkled with green. Abdomen pale whitish-ochreous, base white sprinkled with green. Forewings elongate-triangular, costa moderately arched, apex tolerably rectangular, termen straight, hardly oblique; green mixed with whitish; costal edge whitish-ochreous; first line faintly darker, straight, from before middle of costa to before middle of dorsum; a faint darker median discal dot; second line darker, obscurely whitish-edged posteriorly, from $\frac{3}{4}$ of costa to $\frac{2}{3}$ of dorsum, bent near costa: cilia green, apical half whitish-ochreous. Hindwings greenish-whitish, becoming light green towards termen; cilia light green, tips whitish.

Richmond River, New South Wales (Olliff); one specimen.

*Earias chlorodes*, n. sp.

♂ ♀. 16–21 m.m. Head and thorax whitish-yellowish. Abdomen pale whitish-ochreous. Forewings elongate, rather narrow, hardly dilated, costa gently arched, apex obtuse, termen straight, oblique; whitish-yellow: cilia whitish-yellow. Hindwings whitish, towards termen more or less tinged with ochreous or grey; cilia whitish.

Duaringa, Queensland; Melbourne, Victoria; Carnarvon, West Australia; in October, five specimens.

*Prionophora rhodinastis*, n. sp.

♀. 29–31 m.m. Head, thorax, and abdomen pale ochreous or whitish-ochreous, faintly crimson-tinged. Forewings elongate, gradually dilated, costa gently arched, apex acute, prominent, termen rounded, little oblique; pale ochreous, slightly rosy-tinged, with some fine scattered blackish scales; two blackish discal dots transversely placed beyond middle; a faint darker oblique shade from beneath apex towards middle of dorsum; a præterminal series of blackish dots: cilia ochreous-whitish, base faintly rosy-tinged.

Hindwings whitish-ochreous suffused with light dull rosy-pink; a præterminal row of rather large blackish dots; cilia whitish.

Port Moresby, New Guinea (Kowald); also from Queensland; three specimens.

*Prionophora taphreuta*, n. sp.

♂. 24 m.m. Head fuscous. Thorax fuscous-whitish, with some dark fuscous dots, collar ferruginous-brown. Abdomen pale greyish-ochreous. Forewings elongate, narrow, gradually dilated, apex obtuse, termen bowed, oblique; fuscous irrorated with white, suffused with white in disc and between veins posteriorly; all veins marked with blackish-fuscous lines; a dark fuscous transverse discal mark beyond middle, space between this and second line more fuscous through absence of white suffusion; second line blackish-fuscous, from $\frac{3}{5}$ of costa to $\frac{3}{4}$ of dorsum, obtusely prominent posteriorly at $\frac{1}{4}$ and in middle: cilia fuscous, whitish-sprinkled, obscurely darker-barred. Hindwings light fuscous, somewhat whitish-suffused anteriorly, with a terminal band of rather dark fuscous suffusion; cilia whitish.

Sydney, New South Wales (Raynor); one specimen.

*Prionophora allopis*, n. sp.

♂ ♀. 26–29 m.m. Head and thorax fuscous, suffusedly irrorated with whitish; thorax with small anterior crest. Abdomen pale greyish-ochreous. Forewings elongate, narrow, gradually dilated, apex obtuse, termen bowed, oblique; fuscous, suffusedly irrorated with white; veins more or less strongly marked with blackish-fuscous lines; in ♂ a transverse suffused blackish spot from costa at $\frac{1}{6}$; first and second lines indistinct, fuscous, first somewhat curved, second from beyond middle of costa to beyond middle of dorsum, strongly curved outwards from $\frac{1}{4}$ to below middle; a grey discal spot containing two black scale-tufts placed in this curve, in ♀ surrounded with obscure brownish suffusion; in ♀ small scale-tufts on middle of first line, and on second line below middle and near dorsum; a subapical streak of darker suffusion; in ♀ a series of blackish dots before termen: cilia fuscous sprinkled with whitish. Hindwings whitish-fuscous, becoming fuscous towards dorsum and termen, in ♂ suffused with whitish towards base, and with a terminal band of dark fuscous suffusion; cilia in ♂ white, in ♀ fuscous-whitish.

Kewell, Victoria (Kershaw); two specimens.

*Prionophora charactis*, n. sp.

♂. 28 m.m. Head and thorax fuscous, sprinkled with dark fuscous and whitish. Abdomen light fuscous. Forewings elongate, narrow, gradually dilated, apex obtuse, termen bowed, oblique; fuscous, irregularly irrorated with dark fuscous and whitish; veins more or less strongly marked with black lines; subbasal line obscurely whitish, anteriorly blackish-edged; first and second lines slender, black, first curved outwards, in middle angulated inwards, second from beyond middle of costa to $\frac{2}{3}$ of dorsum, forming a subquadrangular loop outwards from $\frac{1}{3}$ to below middle; subterminal line white, irregular, indented above middle and near dorsum, edged anteriorly near dorsum with a spot of blackish suffusion; an interrupted dark fuscous line before termen; a black terminal line: cilia fuscous sprinkled with white. Hindwings whitish-fuscous, becoming whitish towards base, with a terminal band of dark fuscous suffusion; cilia white, basal half fuscous-tinged.

Melbourne, Victoria (Kershaw); one specimen.

*Timorodes*, n. g.

Forehead with projecting scales. Tongue developed. Antennæ in ♂ ciliated, basal joint with projecting apical tuft of scales in front. Palpi moderate, obliquely ascending, second joint clothed with dense rough scales, terminal joint short, obtuse. Thorax with large posterior crest. Abdomen rather elongate, with expansible crests on first two segments. Femora long-haired beneath. Forewings without raised scales, retinaculum bar-shaped; areole long and narrow. Hindwings: 3 approximated, 4 and 5 connate, 6 and 7 connate, 8 anastomosing with cell to near middle.

Nearest *Labanda*, Walk.

*T. blepharias*, n. sp.

♂. 34 m.m. Head and thorax ochreous-whitish mixed with dark fuscous, basal joint of antennæ white externally, collar and patagia mostly suffused with dark brown. Abdomen white, dorsal crests, apical segment, and base of anteapical fuscous, anal tuft whitish-ochreous. Forewings elongate, slightly dilated posteriorly, costa gently arched, apex obtuse, termen bowed, oblique, tornus rather prominent; rather dark purplish-fuscous; a shining prismatic white broad irregular streak extending from base to middle of disc, brassy-yellowish in fold, upper edge running straight from near base of costa to $\frac{1}{3}$ of disc, thence onwards convex, lower edge with three

slender oblique teeth on veins, dilated at base to dorsum ; beyond apex of this a spot of blackish suffusion, followed by a white dot ; second line faintly indicated, pale, forming two yellowish-white marks on dorsum ; a large white suffused patch extending along costa from $\frac{3}{5}$ to apex, anteriorly reaching half across wing, narrowed posteriorly, lower anterior portion tinged with brassy-yellowish, crossed by traces of second line, and enclosing a small anteapical spot of ground-colour on costa ; subterminal line represented by some whitish lunules, and a small shining white terminal spot above tornus : cilia purplish-fuscous, with narrow whitish bars. Hindwings prismatic white ; a pale fuscous apical patch, extending to middle of termen ; cilia white, on upper half of termen fuscous-tinged.

New Guinea (Sayer) ; one specimen.

*Hypothripa vallata*, n. sp.

♂ ♀. 20–23 m.m. Head and thorax white mixed with grey, thorax more or less barred transversely with brown. Forewings elongate, gradually dilated, costa moderately arched, apex obtuse, termen bowed, little oblique ; white, irregularly and variably mixed with grey and brown ; basal patch usually suffused with dark grey or brown, limited by a blackish line, double on upper half, very obtusely angulated in middle, slightly sinuate below this ; median and second lines fine, irregular, blackish, median nearly straight ; second forming a moderate loop outwards between $\frac{1}{4}$ and $\frac{2}{5}$ ; a roundish dark brown costal spot at $\frac{2}{3}$ ; a slender indistinctly spotted grey subterminal line, sinuate outwards above and below middle, followed on costa by a clear white spot : cilia whitish, sprinkled with dark fuscous. Hindwings whitish, veins infuscated posteriorly ; termen suffused with fuscous, more strongly towards apex ; cilia white, base infuscated.

Brisbane, Queensland (Lucas, Turner) ; five specimens. Nearly allied to the Burmese *H. curiosa ;* but having now obtained several specimens of each species, I find them, though variable, constantly distinct.

*Heteronota*, n. g.

Head with projecting frontal tuft. Tongue developed. Labial palpi long, subascending, second joint thickened with rough projecting scales beneath, terminal joint long, thickened with scales, somewhat pointed. Thorax with apex of patagia forming an expansible scale-tuft. Abdomen with slight crest on second, and more prominent

crests on segments 4–6, that on fifth much largest. Legs with appressed scales. Forewings with tufts of raised scales; areole rather elongate. Hindwings: 3 and 4 rather long-stalked, 5 approximated, 6 and 7 separate, 8 anastomosing with cell shortly near base.

*H. ochthias*, n. sp.

♀. 22 m.m. Head and thorax ochreous-whitish, irregularly sprinkled with blackish. Abdomen ochreous-whitish sprinkled with fuscous, crests mixed with blackish. Forewings suboblong, moderately broad, little dilated posteriorly, apex obtuse, termen rounded, faintly waved, little oblique; white, irregularly sprinkled with fuscous and dark fuscous, except in middle of disc; a coppery-fuscous basal patch, edged with blackish, terminated beneath by a black patch extended along dorsum to middle and bidentate posteriorly; a moderately broad straight dark fuscous fascia from costa before middle to dorsum beyond middle, almost obsolete at lower extremity, near its anterior edge with a ridge of raised scales mixed with ferruginous and blackish; a curved transverse mark of ferruginous and dark fuscous scales in disc at $\frac{2}{3}$; traces of bent second line beyond this; some undefined dots of blackish scales indicating subterminal line: cilia whitish sprinkled with fuscous, obscurely barred with darker. Hindwings whitish-fuscous, becoming fuscous towards termen; cilia whitish.

New Guinea (Sayer); one specimen.

*Sarrothripus crystallites*, n. sp.

♀. 22 m.m. Head and thorax white irrorated with fuscous, collar with a dark fuscous transverse bar. Abdomen grey. Forewings elongate, gradually dilated, costa moderately arched near base, faintly sinuate in middle, apex very obtuse, termen rounded, rather oblique; grey, irrorated with white, with a few fine scattered black scales; subbasal, first, and second lines very fine, black, more or less undefined, very irregular, second indistinctly double, rather curved outwards in disc, obtusely angulated above middle; cilia pale grey, tips whitish. Hindwings with 3 and 4 moderately stalked; white, rather thinly scaled; a moderately broad anteriorly suffused fuscous terminal fascia from above apex to below middle; cilia white, on terminal fascia fuscous-tinged.

Brisbane, Queensland (Lucas); one specimen. This might easily be overlooked as a variety of *Hypothripa vallata*, though the resemblance is only superficial.

## IV. *On Hypotianæ, a new subfamily of Pyralidæ.* By Thomas Algernon Chapman, M.D., F.Z.S.

[Read February 5th, 1902.]

The genus *Hypotia*, Zell., of which there appears to be only one species (*corticalis*, Schiff., s. v.), presents characters, especially in the imaginal and larval stages, that place it in an intermediate position between the *Pyralinæ* and *Phycitinæ*, without permitting it to be properly placed in either. Hence it becomes necessary to give it separate subfamily rank.

It has hitherto been placed in the *Pyralinæ*. M. Ragonot* came very near to recognizing its isolated position. The most obvious point in which *Hypotia* agrees with *Phycitines*, and differs from *Pyralines*, is in the absence of vein 7 of the forewing. M. Ragonot was aware of this, but took the absent vein to be vein 9. I regret that I have not taken advantage of my opportunities to study this vein in the developing pupal wing of *Hypotia* and of *Phycitinæ*, and am quite unable to say positively whether the missing vein be vein 7 or vein 9, but I entertain no doubt whatever that the missing vein, whether it be 7 or 9, is the same vein both in *Phycitinæ* and in *Hypotia*.

By a very remarkable *tour de force*, both Mr. Meyrick † and Sir George Hampson ‡ presented *Hypotia* with the missing vein, and so overlooked the other Phycitine characters it possesses, and easily included it in the *Pyralinæ*.

The imago of *Hypotia* differs from *Pyralinæ* and agrees with *Phycitinæ*, in having lost vein 7, in having vein 1b of forewing simple, and in the ♀ having the frenulum simple.

It differs from *Phycitines*, and agrees with *Pyralines*, in the absence of ocelli, and in the pection of hairs on the hindwing being below, and not on, the lower margin of cell. The neuration of the hindwing is close to that of *Pyralines*, but occurs also in *Phycitines*, and is not specially distinctive.

The larva resembles *Phycitines* not merely superficially; it has, indeed, little in common with *Pyralines*, and agrees

* *Essai sur le classification des Pyralites*, p. 154, 1891.
† *Transactions Entom. Soc. Lond.*, 1890, p. 473.
‡ *Transactions Entom. Soc. Lond.*, 1896, p. 504.

absolutely with *Phycitinæ* in the development, so characteristic of them, of tubercle III. of 12th segment, and shows an alliance with them, in the tendency to a similar development on the thoracic segments, but differs in this affecting tubercle II. of 3rd segment slightly, and of 4th segment strongly, instead of tubercle III. (?) of 3rd segment as in *Phycitinæ*.

The skin texture and markings, the plications of the thoracic subsegments, and the arrangement of the crochets of prolegs are those of *Phycitinæ*, and not of *Pyralinæ*, at least of the typical genera with which I am acquainted.

The pupa has no character to distinguish it from *Phycitinæ*, unless it be that the second leg does not so fully reach up to the maxillary palpus, and that the prothoracic piece is often lost on dehiscence, and not the head piece, which is usually carried away in *Phycitinæ*.

The facies of the imago is certainly not that of a *Phycitine*, but is rather *Pyraustine*.

New subfamily : *HYPOTIANÆ*.

Ocelli absent, proboscis fairly developed, maxillary palpi very short. Forewings triangular, not folded. Vein 1a absent, 1b simple, 1c indicated, 7 absent. Hindwing : line of hairs below, not on lower margin of cell, 4 and 5, widely separate, 6 and 7 sometimes separate, sometimes shortly stalked, 8 free. Frenulum simple in both sexes. Larva with ocelli round tubercle II. of segment 4, and tubercle III. of segment 12 (head = 1st).

*Hypotia*, Zell. Characters of subfamily.

*Hypotia corticalis*, Schiff., s. v.

This very pretty little moth is beautifully figured by Milliere.* He figures also a larva, which may be that of *H. corticalis*, though he says it feeds on *Euphorbia spinosa*. One remark he makes is noteworthy, viz., that the larva much resembles that of a *Phycitine* (*Nephopt. divisella*, Dup.). The figure of the larva is poor, and the description meagre, and not recognizable, even if it belongs to this species. In the Stettiner Zeitung for 1882 Baron v. Nolcken relates how Milliere pointed out to him larvæ in

* *Iconographie*, pl. 82.

the seed-heads of wild carrots as those of *Stemmatophora corsicalis* (*Pyralis obsoletalis*, Mn.), that he collected a number and bred one *H. corticalis*. Milliere evidently made some error, confusing his larvæ or his notes, perhaps owing to the similarity of the names. Baron v. Nolcken gives some details on the habits of the larvæ, noting how some of them went over a second winter after he took them home (to Oesel in the Baltic).

These larvæ are not uncommon at Cannes in the seed heads of wild carrots, on the dead plants of the previous summer.

When I first asked M. Constant what these were, and he told me they were those of *Hypotia corticalis*, I said, "Surely they are some Phycid?" "Yes," he replied, "they are most remarkably like Phycids; nevertheless they are *H. corticalis*." Fearing it might be hopeless to rear them, I did not collect any till last year, when I gathered some in March, and brought them to England. They were of very various sizes, and fed up rather slowly. They seemed very hardy; I never found a dead one (until quite recently) though I treated them to severe alternations of drought and moisture. A number of moths emerged in August and September, July and August being the proper time of appearance on the Riviera. Baron v. Nolcken appears to have reared only one, which came out in October. Some eight or ten of mine remained as larvæ, most nearly full-grown, one or two still small; these, like a similar portion of Baron v. Nolcken's, obviously not intending to emerge till next August. Some of these I preserved; one has since died, the rest seem still (January 1902) active and healthy.

The larvæ live in the seed-heads of *Daucus*, fastening the seeds loosely together, and preventing them falling off, which largely happens in untenanted heads, in spite of the incurving of the umbellules, and the presence of the larvæ is often recognizable by this circumstance. A small spider is often a fellow-lodger with the larvæ—I fancy accidentally, as I think the larva is not often a victim to the spider, nor except a saving in silk do I see any mutual advantage. When the larva is full-grown, and going into its second winter, it spins a more definite silken tube. Its cocoon for pupation is smaller and more solid than the tube ever is. My larvæ always made their nests and cocoons amongst the seed-heads. Baron v. Nolcken says

his crawled away and spun white webs in the corner of his cages, and then dried up. The proportion going over a second year was probably abnormal, owing to poor rations and a colder climate, but it must be to some extent a regular habit, or it would not occur at all.

### *Larva of H. corticalis.*

The larva is of a dull greyish-brown, as the result of a yellowish ground colour, and fine marbled markings or spots, that vary from reddish to blackish-brown. These minute spots are aggregated more closely, and are of darker colour in places, so as to produce the appearance of a narrow dark dorsal line, and a broader one just outside the trapezoidal tubercles. This one is darker and wider in the prothoracic plate. A suffused and indefinite line above, and a more definite narrow one below the spiracles. The supra-spiracular marking is to some extent in diagonal detached pieces, like the lateral stripes in Sphinx. The head is mottled in the same colours as the body.

The tubercles are darker, but not quite black ; they each carry a light-coloured bristle, about 0·8 m.m. in length ; these are slightly porrected. The second tubercles on 3rd and 4th segments (2 and 3 thoracic) have partial (that on 4th nearly complete) dark raised corneous circles round them, and the supra-spiracular tubercle (III.) of the 12th segment (8th abdominal) has a more delicate, but very complete similar ring, precisely as in most Phycid larvæ. The spiracles are raised on conical projections, faintly paler than the general surface, but inconspicuous. The tubercles below the spiracles are on definite smooth areas or plates, that look slightly sunk below the general surface. They are, first, on one plate below the spiracle, two tubercles : one, the lower, immediately below the spiracle, the upper slightly in front of it ; the hairs on these tubercles rather short. Rather lower and at posterior border of the segment a solitary tubercle with long hair. Lower, and at outer and front side of foreleg (on 7–10) a large plate, carrying three short hairs, in one line, the first just above, the third in front of foreleg ; lowest of all, a small tubercle near the middle line. IV. and V. are on one plate, VII. VIII. and IX. on another. The solitary tubercles I. II. III. VI. and X. all have the same structure. The circle surrounding the hair is at the summit of a conical projection, or pyramid, with wrinkled sides, like mountain slopes furrowed by ravines : a not uncommon form of tubercle in Pyralids.

The structure of tubercle IV. in 8th abdominal segment is as though the circle surrounding the hair, instead of at once forming the slope,

was followed by a level of soft pale dermis, and then a larger ring of chitin formed the summit of the conical projection.

The ventral prolegs have a complete circle of hooks, and when expanded, are regularly circular, but contract into an anterior and posterior line, or into a triangle with anterior, posterior and outer sides. The hooks (or crochets) are in two rows, the longer sharply hooked and with long bases, are about twenty-eight in number ; the shorter are between these, are very small, and range with the proximal ends of the bases of the large ones. The anal prolegs have the circlet of hooks largely wanting posteriorly.

There is a large plate on 1st thoracic ; 2nd and 3rd thoracic segments have a subsegmentation of the complicated form common to most Pyralids ; a central subsegment carries the tubercles and is much constricted dorsally, and the marginal ones merge before reaching the spiracular level. This subsegmentation is not nearly so pronounced as in *Pyralis*. The abdominal segments (1–7 at least) are divided into two nearly equal subsegments, or into four, if two faintly-marked and narrow subsegments between the two larger ones be counted as separate.

The general surface has a finely granular or shagreened texture. In places are small, circular, smooth, apparently depressed areas of about the same size as the tubercles. The most conspicuous of these is a row of four on each side of the middle line, along the anterior margins of the abdominal segments. These are frequent in *Phycitinæ* and *Pyraustinæ*.

## *Pupa of H. corticalis.*

From 7-8 m.m. in length. It varies in fact much in size, but less in length than in thickness, a small ♂ being 1·7 m.m., and a ♀ 2·5 m.m. in width, but in length 7 and 8·3 m.m. respectively. Fairly uniform throughout the thoracic mass, but tapering regularly from 5th abdominal ; in the more robust specimens the tapering begins at 3rd abdominal. The ventral aspect of the thoracic mass is fairly straight ; the tapering towards head is done by dorsal rounding, from metathorax forwards.

There is no dorsal head piece, the face piece extends backwards between the antennal bases. It carries two fine hairs opposite the middle of the base of the antennæ. At its oral margin a triangular piece (labrum ?) projects with its lower angle rounded off and notched, and on either side of this, and overlapped by it, is a small rounded lappet (mandible ?). Laterally the eye-region is clearly marked off. Immediately below the free margin of the labrum, the labium begins, and for a third of its length is single, then divides; its total length

is about 0·6 m.m., and it is very slender ; from this as far out as the eyes is the base of the maxilla, which, at first broad, soon narrows and does not quite reach the end of wings. From the labrum to end of appendages is about 4·0 m.m. The maxilla exceeds 3·5 m.m., and where it ceases the 3rd tarsi appear and continue to occupy the central position to the extremity. Outside them the second pair of legs reach the extremity, and then the antennæ usually do so, but are sometimes fractionally short. The first legs are about 3·3 m.m. just outside the maxillæ and a trifle shorter. Beginning at 0·6 m.m. from the labrum and extending to 2·0 m.m., there is between the maxillæ and first leg a spindle-shaped piece, divided by an oblique joint, that is some portion of trochanter and femur of first leg. Beneath the eye-portion of the face is a minute transverse piece (the maxillary palpus), and below it, and of a width exactly equal to the length of the palpus, is the first leg. The second leg touching, or just failing to touch, the palpus, ends here at a sharp angle between first leg and antenna. The basal portion of antennæ above other appendages is very wide. The transverse markings of the antennæ are distinct, but the leg-covers, etc., are so finely sculptured by rows of minute points that they may be called smooth. The labrum has strong transverse ridges. These are finer above, and at the upper part of head are longitudinal. There is a rather strong dark point just above outer angle of labrum, and above and within this a rather strong bristle.

The wings (and appendages) reach nearly to hind margin of 4th segment. The nervures are well marked, and Poulton's line also along the hind margin ; the general surface is smooth, being very minutely dotted.

Close to the apex, just within Poulton's line, is a small, definite, unmistakable bristle, and another at the anal angle similarly just within Poulton's line. In some specimens I cannot discover the latter, and in one specimen the former is wanting, not broken away. This is a most unusual feature in pupæ, perhaps because not looked for.

The prothorax is devoid of bristles, but is very finely spiculated at the margin of the spiracle, some of the spicules being fine and hairlike. On the mesothorax the opposite side of the spiracular opening is also spiculated, but the spicules are very short and small, little more than points ; they extend some distance back on to the outer surface, and gradually merge into the points of the general surface, which are here very minute, rounded and closely packed on the wing-surface, but become large and separate on the dorsum, and have a ringed appearance, being in fact centrally pitted. There are two bristles on the mesothorax, about the middle, one near the middle

line, the other near the wing-base. The metathorax is comparatively small, has fewer and very large punctures, and two bristles, as in mesothorax; the posterior wing stretches down in a narrow strip vanishing about middle of 4th abdominal.

The 1st abdominal segment is small, has pits about the same in size and distribution as on metathorax; these continue on all the following segments, but get gradually smaller, though not very materially. On ten they are absent. On one (abdominal) there is only one bristle (i.), the site of iii. being beneath hindwing. On 2–8 (abdominal) are two bristles (i. and iii.), No. ii. being absent; on 9 is one dorsal bristle (iii. ?). The spiracles of 2nd and 3rd abdominal have the common appearance of having been shoved back by the wing, and of having pushed a ridge of chitin before them. The remaining spiracles are inconspicuous, rather large, with sharp raised margins. Ventrally (4–9) the pits are fewer and smaller. On 5, 6 and 7 only a subspiracular bristle exists ventrally, but there are two on 8 and 9. The anal armature consists of a transverse row of four blunt pyramids, two on either side, each carrying a spine, and two similar projections with spines, further out and rather dorsal. These spines are 0·13 m.m. long, and terminate in a coil, forming a complete circle, so that if straightened out they might be about 0·2 m.m. in length.

V. *Report on a Collection of African* Locustidæ *formed by Mr. W. L. Distant, chiefly from the Transvaal.* By William F. Kirby, F.L.S., F.E.S.

[Read February 5th, 1902.]

The present paper completes my preliminary report on Mr. Distant's collection of African Orthoptera. The *Locustidæ*, by which I understand the grasshoppers and true migratory Locusts, with short antennæ, are both numerous and easily collected; and therefore the number of species and specimens in collections usually exceeds those of other families of Orthoptera. Mr. Distant's collection includes a considerable number of new species, here described, which will, it is hoped, be illustrated, in due course, in the forthcoming parts of his *Insecta Transvaaliensia*.

I have also taken the opportunity of introducing occasional synonymic notes and corrections, and notices of some additional species recorded from the Transvaal, but not obtained by Mr. Distant. Thus enlarged, the present paper enumerates 125 species, and a few obscure or immature forms remain over for further consideration.

In all, two new genera and thirty-three new species are characterized in the present paper, of which seven new species are described under each of the two genera *Chrotogonus*, Serville, and *Xiphicera*, Lamarck.

## LOCUSTIDÆ.

### *ACRYDIIDÆ*

### *Cladonotinæ.*

#### Genus Trachytettix.

*Trachytettix*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 57 (1876); Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 213 (1887).

1. *Trachytettix bufo.*

*Tettix bufo*, Costa, Ann. Mus. Nap., ii, p. 58 (1864).
*Trachytettix bufo*, Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 213 (1887).
*Cladonotus horridus*, Walker, Cat. Derm. Salt., v, p. 844, n. 8 (1871).
*Trachytettix scaberrimus*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 37 (1876).

*Hab.* Transvaal: Zoutpansberg (*Kaessner*), Sterkfontein (*Thomassen*); Natal (*Gueinzius*); Lagos (*Strachan*); Damaraland; Somali (*Bolivar*).

*Acrydiinæ.*

Genus Acrydium.

*Acrydium*, Geoffroy, Hist. Ins., i, p. 390 (1762); Fabricius, Syst. Ent., p. 278 (1775); Leach, Edinb. Encycl., ix, p. 120 (1815), *nec* Latreille.
*Tetrix*, Latreille, Hist. Nat. Crust. Ins., iii, p. 284 (1802).
*Tettix*, Fischer, Orth. Russ., p. 346 (1846), *et auct.*

2. *Acrydium condylops.*

*Tetrix condylops*, Gerstaecker, Arch. f. Nat., xxxv, p. 221 (1869); Von der Decken's Reisen, iii (2), p. 48 (1873).
*Tettix vittata*, Walk., Cat. Derm. Salt., v, p. 821, n. 43 (1871).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*); Natal (*Gueinzius*); Wanga (*Gerstaecker*).
This species appears to have been overlooked by Bolivar in his monograph.

3. *Acrydium latipes.*

*Tettix latipes*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 56 (1876); Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 261 (1887).

*Hab.* Transvaal: Pretoria, Waterberg, Warm Baths (*Distant*), Zoutpansberg (*Kaessner*).
Described by Stål from Damaraland.

### 4. *Acrydium distanti,* sp. n.

Long. corp. 10–13 millim.

Dark brown, slightly varied with reddish in the male, the whole body very thickly and finely granulated, with several large granules on the sides of the pronotum, and on the upper surface of the hind femora. Antennæ short, 14-jointed, the last joint long and pointed. Frontal ridge forming a long narrow fork as far as the middle of the vertex. Pronotum as long as the abdomen, the central carina considerably raised, but only slightly curved; the lateral carinæ in front well-marked, and parallel. Legs rather hairy; front femora almost cylindrical; middle femora broader and flatter; hind femora very broad, ending in a slightly projecting tooth above, preceded, in the male, by a very small one. Hind tibiæ with a double row of rather large spines, 9 on the outer and 7 on the inner edge. Hind tarsi with the first joint very finely serrated above, tripartite beneath, and considerably longer than the 2nd and 3rd together. Ovipositor of the female very large and conspicuous, strongly denticulated beneath. Tegmina and wings not visible.

*Hab.* Transvaal: Zoutpansberg (*Kaessner*, ♂), Rustenburg (*Distant*, ♀).

## Genus Paratettix.

*Paratettix*, Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 270 (1887).

### 5. *Paratettix scaber.*

*Acrydium scabrum*, Thunberg, Nova Acta Upsal., vii, p. 157 (1815).
*Tettix scaber*, Stål, Rec. Orth., i, p. 149 (1873).
*Paratettix scaber*, Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 279, n. 18 (1887).
Var. *Tettix subpustulata*, Walk., Cat. Derm. Salt., v, p. 819, n. 40 (1871).

*Hab.* Transvaal: Pretoria (*Distant*), Zoutpansberg (*Kaessner*), Barberton (*Rendall*); Central Africa; Fort Johnston, Nyasaland (*Rendall*).

A long series of this extremely variable species.

### 6. *Paratettix carinata,* sp. n.

Vertical carina produced backwards over the pronotum and the basal part of the suture of the tegmina in a moderately high and

gradually-rounded crest. General colour red or grey; antennæ yellow, blackish towards the tip. Head and pleura mostly black; pronotum and basal half of tegmina usually bordered by a very distinct yellow line, and the curve of the yellow border of the tegmina is filled up by a long black stripe on each side. Hind femora blackish on the inside, and striated with black above. Tegminæ subacuminate, extending for nearly half their length beyond the abdomen; wings still longer.

Long. corp. 9–10 millim; cum alis 12–14 millim.

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*).

A somewhat variable species, but recognizable in obscurely marked specimens by the raised and regularly curved carinæ.

Genus Coptotettix.

*Coptotettix*, Bolivar, Ann. Soc. Ent. Belg., xxxi, p. 287 (1887).

7. *Coptotettix infausta.*

*Tettix infausta*, Walk., Cat. Derm. Salt., v, p. 820, n. 42 (1871).

*Hab.* Transvaal: Pretoria (*Distant*); S. Africa (*Dr. A. Smith*); Natal (*Gueinzius*).

A rather large specimen, without locality, in the British Museum, is labelled "Aquatic."

*PNEUMORIDÆ.*

Genus Cystocœlia.

*Pneumora* (*Cystocœlia*), Serville, Ins. Orth., p. 713 (1839).

8. *Cystocœlia inanis.*

♂. *Gryllus inanis*, Fabricius, Syst. Ent., p. 827 (1775).

♀. *Pneumore scutellaire*, Latreille, Cuvier, Règne Anim. (ed. 2), iii, pl. xix, f. 1 (1830).

*Pneumora scutellaris*, Burmeister, Handb. Ent., ii, p. 164, n. 10 (1838); Serville, Ins. Orth., p. 713 (1839).

♂ and ♀. Grahamstown (*Schonland*).

There is an immature female, apparently belonging to this species, in the British Museum, which was catalogued

by Walker as *Pneumora ocellata*, Thunberg, a species belonging to the genus *Bulla*, L. The specimen catalogued by Walker as *P. scutellaris* is a female of *Cystocœlia serguttata*, Thunberg, of which *Pneumora obliqua*, Thunberg, is also an immature female form.

*MASTACIDÆ.*

Genus PLAGIOTRIPTUS.

*Plagiotriptus*, Karsch, Entom. Nachrichten, xv, p. 8 (1889).

9. *Plagiotriptus hippiscus.*

*Chorætypus hippiscus*, Gerstaecker, Arch. f. Nat., xxxv, p. 218 (1869); Von der Decken, Reisen in Ost-Afrika, iii (2), p. 42, pl. ii, fig. 8 (1873).
*Plagiotriptus hippiscus*, Karsch, Ent. Nachr., xv, p. 8 (1889).

*Hab.* NYASALAND: Fort Johnston (*Rendall*); Mombasa (*Gerstaecker*), Zomba (*Whyte*, B. M.), Samburu, B. E. AFRICA; collected in November 1896 (*Betton*, B. M.).

*TRYXALIDÆ.*

Genus ACRIDA.

*Gryllus* (*Acrida*), Linnæus, Syst. Nat. (ed. x), p. 427 (1758).
*Acrida*, Stål, Rec. Orth., i, pp. 88, 95 (1877).
*Truxalis*, pt. Fabricius, Syst. Ent., p. 279 (1775).
*Tryxalis*, Bolivar, Feuille Nat., xxiii, p. 41 (1893).

The type of *Truxalis* has been fixed as an American species; the types of *Tryxalis*, Blanchard, belong to the next genus, and therefore *Acrida*, Linnæus, must be retained, with *A. turrita*, Linnæus, as the type.

*A. turrita*, Linnæus, and *A. gigantea*, Fuessly, are usually united under the name of *A. nasuta*, Linnæus; but they appear to be distinct, and the true *A. nasuta* belongs to the following genus.

10. *Acrida turrita.*

*Gryllus* (*Acrida*) *turritus*, Linnæus, Syst. Nat. (ed. x), i, p. 427, n. 12 (1758).
*Acrida turrita*, Stål, Rec. Orth., i, p. 96, n. 3 (1873).

*Hab.* Transvaal: Pretoria (*Distant*), Waterberg, Warm Baths (*Distant*), Barberton (*Rendall*); Natal: Durban (*Ross*); Pemba Island (*Burtt*); Nyasaland: Zomba (*Rendall*); Mozambique: Mopea.

A common African species, with uniform green tegmina, and the lateral carinæ of the pronotum not bordered with black. The wings are transparent, more or less tinged with green or yellowish.

11. *Acrida gigantea.*

*Truxalis gigantea*, Fuessly, Archives, p. 173, pl. 52, f. 6 (1791).

*Tryxalis bilineatus*, Thunberg, Mém. Acad. Pétersb., v, p. 266 (1815); Nova Acta Upsal., ix, p. 82 (1827).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*); Natal: Durban (*Ross*); Nyasaland: Fort Johnston (*Rendall*).

Often confused with the last species, but appears to be distinct; it is found in Africa and the Mediterranean region. The tegmina are green or pale brown, with pink or brown longitudinal markings; the head and pronotum are longitudinally striped with rose-colour on the sides and sometimes on the median line; the lateral carinæ are generally bordered within with black lines, and the wings are tinged with yellowish.

12. *Acrida rendalli*, sp. n.

Long. corp. 60 millim; exp. al. 120 millim.

*Female.* Head and thorax green. Frontal protuberance extending beyond the eye to about $\frac{2}{3}$ of the length of the latter, with parallel sides, and cut off almost square at the extremity, its lateral margins, in front of the eye, brown. Antennæ with the basal joint testaceous, the rest wanting. Behind the eye runs a very pale yellow lateral stripe, broadening behind, to the extremity of the head; it is bordered beneath by a slender black line. It is continued by a similar pale yellow band on the thorax, below the lateral carinæ. This band is obsolete before and behind, as is also a black line bordering it below. The lateral carinæ are yellow, and bordered above with slender black lines, obsolete behind; the lower terminal lateral carinæ are yellow, unmarked with black. The hinder part of the prothorax is slightly expanded above, convex and slightly longitudinally striated; the front of the head and the hinder part of the

prothorax are marked with a slight median carina, otherwise obsolete. Abdomen brown (perhaps reddish in life ?) above, and buff below. Tegmina green, except the tips, which are lilac (perhaps discoloured ?); there are traces of an interrupted brown longitudinal stripe. Basal half of wings and principal nervures throughout clear rose-colour, unspotted; outer half hyaline. Longitudinal and transverse nervures towards the tips mostly green; transverse and intercalated nervures mostly blackish in the middle, and reddish towards the anal angle. Legs green, tarsi rufo-testaceous.

*Hab.* TRANSVAAL: Barberton (*Rendall*).

It is extremely difficult to determine the number of species in this group, and the present insect would perhaps be regarded by some entomologists as a red-winged variety of *A. turrita* or *gigantea*.

### 13. *Acrida aspersata*, sp. n.

Long. corp. 64 millim; exp. al. 110 millim.

*Female.* Head, thorax, legs and tegmina green. Head with a single black lateral line behind the eye, thorax with double black lines, meeting in front, obsolete behind, and bordered with yellow lines, on the upper and middle lateral carinæ. Hinder part of thorax slightly expanded, pointed behind, and longitudinally striated. Abdomen and hind femora greenish and buff, with black longitudinal spots on the back. Tegmina green, the costa edged by a black line; a central longitudinal black stripe, undulated and filled up with yellow lines above, and broken into spots at $\frac{2}{3}$ of the length of the tegmen. Wings rose-colour, except on the apical third, where they are greenish-hyaline; and with most of the interspaces between the transverse nervures marked with small blood-red spots.

*Hab.* EAST AFRICA: Masongolem, 3000 feet (*Scott Elliot*) (Brit. Mus.); TRANSVAAL, Barberton (*Rendall*).

The species is described from Mr. Scott Elliot's specimen. Mr. Rendall's is more faded; but the head, prothorax, and tegmina are striped with rose-colour, and the space below the wings is marked obliquely with black and rose-colour. In the other specimen, it is indistinctly marked with green and black.

### 14. *Acrida acuminata*.

*Acrida acuminata*, Stål, Rec. Orth., p. 97 (1873).

*Hab.* TRANSVAAL: Barberton (*P. Rendall*).

One specimen, differing from Stal's description in wanting the dark lines towards the tips of the wings.

15. *Acrida sulphuripennis.*

*Tryxalis sulphuripennis*, Gerstaecker, Arch. f. Nat., xxxv, p. 215 (1869); Von der Decken's Reisen, iii (2), p. 33, pl. iii, fig. 1 (1873).

*Hab.* Transvaal: Pretoria (*Distant*); Natal: Durban (*Distant*); Zanzibar (*Gerstaecker*).

One of the smaller species of the genus, and apparently not very common.

16. *Acrida madecassa.*

*Tryxalis madecassa*, Brancsik, Jahresb. Ver. Trencsen, xv, p. 186 (1893).

*Hab.* Nyasaland: Fort Johnston (*Rendall*).

A single example, agreeing with specimens in the British Museum from Madagascar.

17. *Acrida rufescens.*

*Truxalis rufescens*, Palisot de Beauvois, Ins. Afr. Amér., p. 17; Orth., pl. ii, fig. 2 (1805).
*Acrida rufescens*, Stål, Rec. Orth., i, p. 97 (1873).

*Hab.* Nyasaland: Fort Johnston (*Rendall*).

A well-known West African species.

Genus Tryxalis.

*Tryxalis*, Blanchard, Hist. Nat. Ins., iii, p. 36 (1840).
*Acridella*, Bolivar, Feuille Jeune Nat., xxiii, p. 41 (1893).

18. *Tryxalis nasuta.*

*Gryllus (Acrida) nasutus*, Linnæus, Syst. Nat. (ed. 10), i, p. 427, n. 11 (1758).

*Hab.* Transvaal: Rustenburg (*Distant*).

A single pair. The male (from Rustenburg) has pale yellow wings; the female (without locality) has the base of the wings tinged with purple and red, and many of the longitudinal nervures red. The male is very similar to *A. variabilis*, Klug, and has no red or vinous colour on the hind wings; but the two insects exhibit so many points of resemblance that I have ventured to put them together.

19. *Tryxalis serrata.*

*Truxalis serratus*, Thunberg, Mém. Pétersb., v, p. 269 (1815); Nov. Acta Upsal., ix, p. 84 (1827).
*Acrida serrata*, Stål, Rec. Orth., i, p. 100 (1873).
*Tryxalis nasuta*, Blanchard, Hist. Nat. Ins., iii, p. 36, pl. 10, fig. 1 (1840).
*Truxalis constricta*, Schaum, Peters' Reise Mossamb., v, p. 129, pl. vii A, fig. 1 (1862).
*Tryxalis lativitta*, Walk., Cat. Derm. Salt., B. M., iii, p. 496, n. 8 (1870).

*Hab.* Transvaal: Pretoria (*Distant*).

Genus Amycus.

Stål, Œfv. Vet. Akad. Förh., xii, p. 353 (1855); Rec. Orth., pp. 89, 100 (1873).
*Parga*, Walker, Cat. Derm. Salt., iii, p. 804 (1870).

20. *Amycus rhodiopterus.*

*Amycus rhodiopterus*, Stål, Œfv. Vet. Akad. Förh., xii, p. 353, n. 2 (1855).

*Hab.* Transvaal: Pretoria, Masil. Nek (*Distant*); Port Natal (*Stål*).

Genus Phlæoba.

*Gomphocerus* (*Phlæoba*), Stal, Eugenie's Resa, p. 340 (1860).
*Phlæoba*, Stål, Rec. Orth., i, pp. 92, 107 (1873).

21. *Phlæoba basalis.*

*Opomala basalis*, Walk., Cat. Derm. Salt., iii, p. 510, n. 20 (1870).
*Phlæoba chloronota*, Stal, Œfv. Vet. Akad. Förh., xxxiii (3), p. 48 (1876).
*Phlæoba viridula*, Krauss, Sitzungsber. Math. Nat. Cl. Wien, lxxvi (1), p. 52 (1877).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*); Delagoa Bay (*Distant*); Nyasaland: Fort Johnston (*Rendall*).

22. *Phlæoba interlincata.*

*Opomala interlincata*, Walk., Cat. Derm. Salt., iii, p. 510, n. 21 (1870).
*Phlæoba viridula*, var. *liturata*, Bol., Jorn. Sci. Lisb. (2), i, p. 98 (1899).

*Hab.* Transvaal: Pretoria; and another female specimen without special locality (*Distant*); Natal (*type*); Nyasaland (B. M.).

This species is common in Nyasaland, where the black stripes are a little narrower than in the type from Natal. Bolivar regards it as a variety of *P. chloronota*, Stal (= *Opomala basalis*, Walker), which he and Krauss incorrectly regard as identical with *Truxalis viridula*, Beauv., which is really a synonym of the American *T. brevicornis*, Linn.

One specimen from Pretoria differs in having a broad double black band on each side of the central line on the hinder half of the vertex; in wanting the usual black lines on the pronotum; and in the hind femora being blackish on both sides. But without a long series of specimens from the same locality, to show variation, and to check the effects of possible discoloration, it is difficult to deal with Orthoptera satisfactorily.

## Genus Duronia.

*Duronia*, Stâl, Bihang Vet. Akad. Handl. (4), v, p. 21 (1876).

The types of this genus are *D. semicarinata*, Gerst., and *D. chloronota*, Stâl, the latter of which is a synonym of *Phlæoba basalis*, Walk.; but Brunner employs the name for some Burmese species which are not congeneric.

23. *Duronia stenoptera.*

*Chrysochraon stenopterus*, Schaum, Mon. Berl. Akad., 1853, p. 779; Peters' Reise nach Mossamb. Zool., v, p. 133, pl. vii A, fig. 4 (1862).
*Chrysochraon semicarinatus*, Gerst., Arch. f. Nat., xxxv, p. 218 (1869); Von der Decken, Reisen, iii (2), p. 39 (1873).

*Hab.* Transvaal: Eureka near Barberton (*Rendall*); Mozambique (*Schaum*); Wanga (*Von der Decken*).

24. *Duronia tricarinata.*

*Duronia tricarinata*, Bol., An. Soc. Esp., xix, p. 312 (1890).

*Hab.* TRANSVAAL: Pretoria (*Distant*), Barberton (*Rendall*); Zoutpansberg (*Kaessner*); ASHANTI (*Bolivar*).

Genus ORTHOCHTHA.

*Orthochtha*, Karsch, Berl. Ent. Zeitschr., xxxvi, p. 177, note (1891).

25. *Orthochtha dasycnemis.*

*Chrysochraon dasycnemis*, Gerst., Arch. f. Nat., xxxv, p. 217 (1869); Von der Decken, Reisen in Ost.-Afrika, iii (2), p. 38, pl. iii, fig. 2, 2a (1873).

*Hab.* NYASALAND: Fort Johnston (*Rendall*).

Genus PARACINEMA.

*Paracinema*, Fischer, Orth. Eur., p. 312 (1870); Stål, Rec. Orth., i, pp. 91, 103 (1873).

26. *Paracinema tricolor.*

*Gryllus tricolor*, Thunberg, Mém. Acad. Pétersb., v, p. 245 (1815), ix, p. 419 (1824).
*Paracinema tricolor*, Brunner, Prodr. Europ. Orth., p. 97, pl. iv, fig. 26 (1882).

*Hab.* TRANSVAAL: Pretoria, Masil. Nek (*Distant*); NYASALAND: Fort Johnston (*Rendall*).

A common species throughout a great part of Southern Europe, Asia, and Africa. The full synonymy is given by Brunner.

Genus PNORISA.

*Gomphocerus* (*Pnorisa*), Stål, Eug. Resa, p. 341 (1860).
*Pnorisa*, Stål, Rec. Orth., i, pp. 93, 107 (1873); Œfv. Vet. Akad. Förh., xxxiii (3), p. 47 (1876).

27. *Pnorisa squalus.*

*Gomphocerus* (*Pnorisa*) *squalus*, Stal, Eug. Resa, p. 341 (1860).
*Pnorisa squalus*, Stål, Efv. Vet. Akad. Förh., xxxiii (3), p. 48 (1876).

*Hab.* Transvaal: Pretoria (*Distant*); Cape (Stål); B. C. Africa, Baringo (*Betton*).

28. *Pnorisa capensis.*

*Stenobothrus capensis*, Walk., Cat. Derm. Salt., iv, p. 764, n. 62 (1870).

*Hab.* Transvaal: Pretoria (*Distant*); S. Africa (*Trimen*).

Very similar to the last species, but darker and less distinctly marked.

Genus Diablepia, g. n.

Fastigium nearly as long before the eyes, as the head behind them; convex on the median line to the extremity, where it is subcarinated, and curves slightly downwards; the carina is slightly oval, rounded in front, and there is a slight depression between it and the median elevated front of the head. Middle carinæ of the face meeting in a point above, but subparallel below, slightly approximating in the middle at the frontal ocellus. Lateral carinæ of the face slender, starting from below the antennæ, and curving slightly outwards at their lower extremity. Antennæ about 21-jointed, ensiform, broadest and flattest towards the base. Pronotum ¼ longer than the head; about twice as long as broad, with three well-marked carinæ, the lateral ones slightly converging on the hinder part; transverse sutures barely indicated. Outside the central carinæ are two additional rudimentary carinæ, parallel, and slightly indicated to the front of the fastigium of the vertex, where they meet in a point. Antennæ inserted close to, and just below the front of the eyes; face much sloped, deflexed sides of pronotum less so, forming an obtuse angle in front, and almost a right angle behind; lower side nearly straight, hinder edge of pronotum above slightly projecting behind, almost rectangular, but with the angle rounded off at the extremity. Tegmina rather longer than the abdomen, femora and tibiæ rather hairy, femora not very thick, about as long as the abdomen, with the pattern on the outer median area irregular, the angles

being very acute, and the series of upper and lower raised lines being separated by a longitudinal waved line. Tibiæ as long as the femora, with about eleven spines on each side.

Allied to *Phlæoba* and *Duronia*, from which it is at once distinguished by the depression on each side of the fastigium not meeting in front.

28A. *Diablepia viridis*, sp. n.

Long. corp. 24 lin.

Grass-green; antennæ, except the basal joint, ferruginous or blackish; costa and extremity of the tegmina, upper side of the hind femora, and probably more or less of the wings, pale rose-colour; in one specimen the space between the inner rudimentary carinæ of the head and pronotum is filled up by a narrow cream-coloured, or very pale yellow stripe, which is continued along the suture of the tegmina. Head and sides of pronotum with numerous fine irregular reticulations. Spines of hind tibiæ pale yellow, tipped with black. First joint of tarsi about as long as the two following ones together, bilobate beneath; second rather shorter than the third, and slightly produced beneath at the extremity.

*Hab.* Transvaal: Pretoria (*Distant*).

Genus Gymnobothrus.

*Gymnobothrus*, Bolivar, Jorn. Sci. Lisboa (2), i, p. 100 (1889).

29. *Gymnobothrus linea alba.*

Bolivar, l. c. (1889).

*Hab.* Transvaal: Pretoria (*Distant*).

Appears to be a common species.

Genus Chortoicetes.

*Chortoicetes*, Brunner, Ann. Mus. Genov., xxxiii, p. 123 (1893).

30. *Chortoicetes prasina.*

*Epacromia* (?) *prasina*, Walk., Cat. Derm. Salt., iv, p. 770, n. 9 (1870).

*Hab.* Transvaal: Pretoria (*Distant*); Cape Colony: Cape Town (*Trimen*), Grahamstown (*Schonland*).

One of the commonest grasshoppers at Pretoria. It is very probably identical with *C. socius*, Stal, in which case the latter name should be retained. The specimens vary a little in size, pattern and the colour of the legs, but appear all to belong to the same species.

One specimen is labelled: "With swarm of red locusts, Pretoria, November 1894."

### 31. *Chortoicetes plena.*

*Epacromia plena*, Walk., Cat. Derm. Salt., iv, p. 969, n. 8 (1870).

*Acridium* (*Œdipoda*) *caliginosa*, var. *β*, De Haan, Verhand. Orth., p. 162 (1842).

*Hab.* TRANSVAAL: Pretoria, Rustenburg, Waterberg, Warm Baths (*Distant*).

### 32. *Chortoicetes minusculus.*

*Stenobothrus minusculus*, Walk., Cat. Derm. Salt., iv, p. 763, n. 61 (1870).

*Hab.* NYASALAND: Fort Johnston (*Rendall*); CAPE (*Trimen*).

## *LOCUSTIDÆ.*

### Genus COSMORHYSSA.

*Cosmorhyssa*, Stål, Rec. Orth., i, pp. 116, 121 (1873); Saussure, Mém. Soc. Genève, xxviii (9), pp. 50, 123 (1884), xxx (i), pp. 18, 37 (1888).

### 33. *Cosmorhyssa fasciata.*

*Gryllus fasciatus*, Thunberg, Mém. Acad. Pétersb., v, p. 230 (1815); ix, p. 403 (1824).

*Cosmorhyssa fasciata*, Stal, Rec. Orth., i, p. 121 (1873); Saussure, Mém. Soc. Genève, xxviii (1), p. 124 (1884).

*Gryllus sanguineus*, Thunberg, l. c., v, p. 231 (1815): ix, p. 404 (1824).

*Œdipoda strigata*, Serville, Ins. Orth., p. 726 (1839).

*Hab.* TRANSVAAL: Pretoria (*Distant*), Barberton (*Rendall*); DELAGOA BAY (*Distant*); PEMBA ISLAND (*Burtt*); NATAL; KILIMANJARO; SIERRA LEONE; GABOON (B. M.);

Nyasaland: Fort Johnston (*Rendall*); British Central Africa: Zomba (*Rendall*).

A common and widely distributed African species. Mr. Distant's is a very pale specimen, and had perhaps been some time on the wing when captured.

### 34. *Cosmorhyssa sulcata.*

*Gryllus sulcatus*, Thunberg, Mém. Acad. Pétersb., v, p. 234 (1815).

*Cosmorhyssa sulcata*, Stal, Rec. Orth., i, p. 122 (1873); Saussure, Mém. Soc. Genève, xxviii (9), p. 124 (1884).

*Hab.* Transvaal: Pretoria (*Distant*).

## Genus Gastrimargus.

*Gastrimargus*, Saussure, Mém. Soc. Genève, xxviii (9), pp. 109, 110 (1884), xxx (i), p. 37 (1888).

### 35. *Gastrimargus determinatus.*

*Pachytylus determinatus*, Walker, Cat. Derm. Salt., v, Suppl., p. 72 (1871).

*Œdaleus verticalis*, Saussure, Mém. Soc. Genève, xxviii (9), p. 111 (1884).

*Hab.* Transvaal: Pretoria, Masil. Nek (*Distant*); Natal; Knysna, Marabastaat (B. M.).

### 36. *Gastrimargus marmoratus.*

*Gastrimargus marmoratus*, var. β, Thunberg, Mém. Acad. Pétersb., v, p. 232 (1815); ix, p. 411, pl. 14, fig. 4 (1824).

*Pachytylus* (*Œdaleus*) *marmoratus*, Stál, Rec. Orth., i, p. 123 (1873).

*Œdaleus marmoratus*, Saussure, Mém. Soc. Genève, xxviii (1), p. 112 (1884).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Distant*); Nyasaland: Fort Johnston (*Rendall*).

A common species throughout the warmer parts of the Old World.

37. *Gastrimargus acutangulus.*

*Pachytylus* (*Œdaleus*) *acutangulus*, Stål, Rec. Orth., i, p. 125 (1873).

*Hab.* Transvaal: Pretoria? (*Distant*) Caffraria (*Stal*).

Mr. Distant's collection contains a single damaged specimen of this beautiful species, without precise locality. It is quite distinct from the species which Saussure describes under the same name; for Stål's species has blue wings, and Saussure's yellow wings. As Stål's description is short, and Saussure's applies to another species, I add here a full description of Mr. Distant's specimen.

Long. corp. 40 millim. ; long. pron. 10 millim. : lat. pron. 8 millim.

*Female.* Intermediate between *G. determinatus*, Walker, and *G. marmoratus*, Thunb., but nearer to the former. Ground colour testaceous ; the central and lateral carinæ of the vertex very slightly indicated, but visible ; a double black line before and behind each eye ; a brown streak, commencing in a point, just above the central ocellus, on the frontal ridge ; and a slightly-indicated brown line bordering the sides of the ridge on the outside ; lower orbits, mandibles, and an oblique stripe on the cheeks from the upper surface of the mandibles, black. Antennæ, except two pale basal joints, wanting. Pronotum granulated, with the central carina considerably raised, and the hinder angle long and acute, as in *G. determinatus* ; central carina pale yellow, narrowly bordered on the sides with blackish, the upper stripe from the eye continued to the first sulcus, and followed by another black stripe, tapering at each extremity ; the lower line from the eye expands into a black triangle, scarcely continued beyond the principal sulcus, and surrounded by yellowish, which takes the form of an angulated stripe above it, and an irregular band below, from the first sulcus to the hind margin of the pronotum. Below it is another triangular black spot, extending from the fore border of the pronotum to the principal sulcus, and marked behind at the lower angle by a yellow spot. Abdomen shining black above, and testaceous below, and on the sides, which exhibit a double row of black dots. Legs rufo-testaceous ; hind femora spotted with black on all the carinæ ; the inside black, with light blue transverse bands; hind tibiæ and tarsi red, the spines of the tibiæ yellowish, and tipped with black. Tegmina brown towards the base, the costal area varied with yellowish subhyaline ; the anal area darker yellowish above, and brown at the base and below ; the intermediate basal area brown, varied by a

double row of whitish spots; the apical portion of the wing subhyaline, with two large transverse black blotches, enclosing more or less transparent spaces; the second is indeed almost divided into brown and transparent longitudinal streaks, connected by a brown transverse band on the inner side; and it is followed by two series of long brown stripes on the nervures; (extremity of the tegmina broken). Wings with the basal third white, with strongly-marked blue nervures, which are sufficiently close together at the base to give the wing a distinctly blue appearance at that point; this inner portion of the wing is bordered by a very broad blue-black band, extending from the costa, and covering a considerable portion of the hind margin as far as the anal angle; the outer part of the wing transparent, with brown nervures, varied in the upper portion by pale yellow ones: beyond which are three irregular brown longitudinal stripes, but the extremities of the wings, as well as of the tegmina, are wanting.

Described from a single broken specimen from the Transvaal, without special locality. The markings of the femora alone are sufficient to distinguish it from *G. dohrnianus*, Sauss., which has also blue hind wings.

### 37A. *Gastrimargus dohrnianus.*

*Œdaleus* (*Gastrimargus*) *dohrnianus*, Saussure, Mém. Soc. Genève, xxx (1), p. 166 (1888).

*Hab.* TRANSVAAL (Dohrn's collection).
Not in Mr. Distant's collection.

## Genus ŒDALEUS.

*Œdaleus*, Fieber, Lotos, iii, p. 126 (1853); Stål, Rec. Orth., i, p. 123 (1873); Saussure, Mém. Soc. Genève, xxviii (9), pp. 110, 115 (1884), xxx (1), pp. 18, 37, 40 (1888).

### 38. *Œdaleus flavus.*

*Gryllus* (*Locusta*) *flavus*, Linnæus, Syst. Nat. (ed. x), i, p. 433, n. 53 (1758); (Pet. Gaz., pl. 3, fig. 6, *fig. typ.*).
*Acrydium nigrofasciatum*, De Geer, Mém. Ins., iii, p. 493, pl. 41, fig. 5 (1773).
*Pachytylus* (*Œdaleus*) *nigrofasciatus*, Stål, Rec. Orth., i, p. 126 (1873).

*Œdaleus nigrofasciatus*, Saussure, Mém. Soc. Genève, xxviii (9), p. 116 (1884), xxx (1), p. 40 (1888).

*Hab.* Transvaal: Pretoria (*Distant*); Cape Colony: Grahamstown (*Schonland*).

A common species throughout the warmer parts of the Old World. Petiver's figure, which must be taken as typical of Linné's *flavus*, appears to represent this species.

## Genus Locusta.

*Gryllus* (*Locusta*), Linnæus, Syst. Nat. (ed. x), p. 431 (1758); Schrank, Enum. Ins. Austr., p. 246 (1781); Samouelle, Ent. Compend., p. 218 (1819).

*Gryllus*, Fabricius, Syst. Ent., p. 287 (1775), *haud recte*.

*Acrydium*, Latreille, Hist. Nat. Crust. Ins., iii, p. 282 (1802), *nec* Geoffroy.

*Pachytylus*, Fieber, Lotos, iii, p. 21 (1853); Stal, Rec. Orth., i, pp. 116, 122 (1873): *et auct. al.*

### 39. *Locusta danica*.

*Gryllus* (*Locusta*) *danicus*, Linnæus, Syst. Nat. (ed. xii), i (2), p. 702, n. 38 (1758).

*Gryllus cinerascens*, Fabr., Spec. Ins., i, p. 369, n. 57 (1781).

*Hab.* Nyasaland: Fort Johnston, Zomba (*Rendall*).

Two very dark specimens, one very large; and a third small pale specimen.

One of the commonest locusts in most parts of the Old World.

### 40. *Locusta pardalina*.

*Pachytylus pardalinus*, Walker, Cat. Derm. Salt., iv, p. 725, n. 7 (1870).

*Pachytylus sulcicollis*, Stal, Efv. Vet. Akad. Förh., xxxiii (3), p. 50 (1876).

*Pachytylus capensis*, Saussure, Mém. Soc. Genève, xxviii (9), p. 119 (1884), xxx (1), p. 43 (1888).

*Hab.* Transvaal: Pretoria (*Distant*).

One specimen is marked, "With swarm of red locusts, November 1894." It is probably this species which has been confounded with the Abyssinian *L. migratorioides*, Reiche, by some authors on South African locusts.

41. *Locusta migratorioides.*

*Œdipoda migratorioides*, Reiche, Voy. Abyss., iii, p. 430, pl. 28, fig. 12 (1847).

*Hab.* Nyasaland: Fort Johnston (*Rendall*); Abyssinia; Angola; Sierra Leone; Las Palmas (B. M.).

A widely-distributed species in Africa. The blue-black mandibles are very characteristic.

Genus Heteropternis.

*Heteropternis*, Stål, Rec. Orth., i, pp. 117, 148 (1873); Saussure, Mém. Soc. Genève, xxviii (9), pp. 53, 129 (1884), xxx (1), pp. 19, 45 (1888).

42. *Heteropternis vittata*, sp. n.

Long. corp. 25 millim.; exp. al. (circa) 48 millim.

*Female.* Black, face indistinctly mottled with paler, antennæ reddish above, brown below, palpi conspicuously pale yellow. Pronotum dull black, only one suture crossing the central carina a little before the middle; just behind it is a broad pale band, probably red in life, occupying the front half of the space between its commencement and the apex of the pronotum; it is narrowest at the central carina, and broadest above at the sides, where it drops straight down, extending on the overlapping sides to their hinder extremity; in front of it are two small yellow spots on the black sides of the pronotum; the obtuse hinder angle of the pronotum above is black. Abdomen testaceous, shining black above, and with broad black bands on the side of each segment, and with narrow black ones towards the base of the front segments beneath. Hind femora black, mottled with yellowish; lower inner carina, hind tibiæ (except the base and spines, which are black) and the hind tarsi, except the black middle joint, red. Tegmina blackish, the cells paler, except towards the median line, two small yellow dots at $\frac{1}{3}$ of their length, and a transverse short whitish stripe at $\frac{2}{3}$. Wings smoky brown, subhyaline, with the basal half red.

*Hab.* British Central Africa: Zomba (*Rendall*).

Probably allied to *H. pudica*, Saussure.

Described from a single specimen. There is an immature specimen of what is probably an allied species, from Pretoria (*Distant*).

Genus Pycnodictya.

*Pycnodictya*, Stål, Rec. Orth., i, pp. 116, 121 (1873); Saussure, Mém. Soc. Genève, xxviii (9), pp. 55, 144 (1884), xxx, p. 20 (1888).

43. *Pycnodictya obscura.*

*Gryllus* (*Locusta*) *obscurus*, Linnæus, Syst. Nat. (ed. x.), i, p. 433, n. 52 (1858).
*Pycnodictya obscura*, Saussure, Mém. Soc. Genève, xxviii (1), p. 145 (1884).
*Œdipoda rosacea*, Serville, Ins. Orth., p. 728 (1839).

*Hab.* Transvaal: Pretoria (*Distant*).
A considerable number of specimens, varying a little in size and colour.

Genus Tmetonota.

*Tmetonota*, Saussure, Mém. Soc. Genève, xxviii (9), pp. 56, 459 (1884), xxx (1), pp. 21, 54 (1888).

44. *Tmetonota abrupta.*

*Œdipoda abrupta*, Walker, Cat. Derm. Salt., iv, p. 739, n. 76 (1870).
*Trilophidia rugosa*, Stål, Rec. Orth., i, p. 132 (1873).

*Hab.* Transvaal: Pretoria, Rustenburg (*Distant*); Natal (*Krauss*); Caffraria (*Stål*).
I am not certain whether Saussure has correctly determined Stål's *T. rugosa*.

Genus Acrotylus.

*Acrotylus*, Fieber, Lotos, iii, p. 125 (1853); Stal, Rec. Orth., i, pp. 119, 135 (1873); Saussure, Mém. Soc. Genève, xxviii (1), pp. 51, 58, 186 (1884), xxx, pp. 21, 23, 68 (1888).

45. *Acrotylus*, sp.

One or more species, not yet accurately determined.

EREMOBIIDÆ.

Genus Batrachotettix.

*Batrachotettix*, Burmeister, Handb. Ent., ii, p. 796 (1839); Saussure, Mém. Soc. Genève, xxviii (9), pp. 63, 236 (1884), xxx, pp. 123, 142 (1888).

46. *Batrachotettix scutellaris.*

*Trachypetra bufo*, White (*nec* Burmeister), Methuen, Wanderings in Wilderness S. Africa, p. 317, pl. ii, fig. 3 (1846).
*T. scutellaris*, Walker, Cat. Derm. Salt., iv, p. 795, n. 3 (1870).
*Batrachotettix whiti*, Saussure, Mém. Soc. Genève, xxx (1), p. 148 (1888).

*Hab.* Grahamstown (*Schonland*).

## PYRGOMORPHIDÆ.

### *Chrotogoninæ.*

### Genus Chrotogonus.

*Chrotogonus*, Serville, Ins. Orth., p. 702 (1839); Bolivar, An. Soc. Esp., xiii, p. 37 (1884).

47. *Chrotogonus angustipennis*, sp. n.

Long. corp. cum tegm. 20–23 millim.

Uniform brown, strongly granulated, and very pubescent. Facial carinæ rather broad, subparallel, scarcely divergent below, rising on the vertex within the eyes, in front of two large tubercles, an oblique carinæ on the lower part of the cheeks. Prothorax with three raised carinæ on the median line, as in *C. capitatus*, but with only one slightly oblique carina running to the base of each tegmen. Pronotum produced behind in a rectangle. Tegmina very narrow, a little longer than the abdomen, with a large dark band about the middle. Antennæ testaceous, mostly black on the apical half; legs testaceous, banded with black; hind femora darker outside, with a large black spot in the middle above, and black spots on the carinæ below; inside of hind femora black, with a conspicuous yellowish band before the extremity. Abdomen spotted with black on the back above, towards the base, in the female; in the male there is also a double row of black spots beneath, and the terminal segment is likewise black beneath.

*Hab.* Transvaal: Pretoria (*Distant*).
Described from one male and two females.

### 48. *Chrotogonus capitatus*, sp. n.

Long. corp. cum tegm. 20–24 millim.

Dark brown, head and thorax very rugose, and strongly granulated. Facial carinæ broad, undulating, diverging beneath, imperfect carinæ running down both before and behind the eye. Vertex with two arched carinæ between the eyes; antennæ testaceous, varied with black on the terminal half. Behind the carinæ on the vertex several smaller ridges run backwards, diverging. On the occiput stands a large black triangle, between which and the ridges (which are placed on an imperfect black band) is an oblique tawny band spotted with black. Prothorax (viewed from the side) trilobate; on each side of the first ridge stands a lower carina, and on each side of the central carina of the hinder lobe of the prothorax are three more carinæ, two short, terminal, and the third more central. Hinder lobe of the prothorax triangularly produced, and broadly truncate at the extremity. Tegmina brown, indistinctly spotted with darker brown, with very strongly-marked raised nervures and several rows of granules. Abdomen thickly punctured, under-surface tawny in front, yellow further back, and blackish towards the extremity, and marked with a double row of large black spots. Middle femora carinated, hind femora strongly granulated, tibiæ spotted with blackish.

Long. corp. 24 millim.

*Hab.* Transvaal: Pretoria (*Distant*).

Three specimens—two males and one female; the female is much more uniformly coloured than the type, and wants the peculiar markings on the head. It has also two more distinct blackish bands across the tegmina.

### 49. *Chrotogonus meridionalis.*

*Chrotogonus meridionalis*, Saussure, Dist. Nat. Transv., p. 262, pl. iv, fig. 5 (1892).

*Hab.* Transvaal: Zoutpansberg (*Distant*).

### 50. *Chrotogonus distanti*, sp. n.

*Male.* Clay-yellow, varied with black on the head, thorax, and basal segments of the abdomen; antennæ black, with the basal joints, and one or two isolated joints of the flagellum indistinctly reddish. Front moderately long, tricarinate, the lateral carinæ ending in tubercles within the eyes. Back of head grey in the middle,

followed by a black, and then by an orange spot on each side ; space behind the eyes black, lower parts of head whitish, with black dots and whitish tubercles ; a large pale tubercle on each side near the middle of the face. Thorax very rugose and tuberculate, front edge with two black tubercles in the middle, hinder edge rounded and lobate, the middle lobe and the lateral angles tipped with orange, between which are five black tubercles on each side. Tegmina rounded, tuberculate, not longer than the metathorax. Abdomen and hind femora slightly tinged with reddish, and with numerous small white tubercles. Legs above clay-yellow, indistinctly mottled with darker ; knees and tibiæ varied with blackish. Hind femora beneath and within yellowish, spotted with black on the carinæ. Under-surface of body mostly yellowish ; pectus irregularly spotted with black ; abdomen with a double row of large black spots, and a row of smaller dots above the lateral division.

*Female.* Similar, but larger and darker, the antennæ and tibiæ black, banded with grey ; in one specimen the lower part of the face is blackish. In some specimens the whole insect is much veined with whitish ; the face, the hinder lobe and part of the middle lobe of the prothorax, the pleura, and the greater part of the basal half of the hind femora being whitish with black spots. The tegmina are longer than in the male, extending to, or nearly to, the extremity of the smooth basal half of the first segment of the abdomen. The upper lateral spots on the abdomen much larger than in the male.

Long. corp. ♂ 12 millim. ; ♀ 19–21 millim.

*Hab.* Transvaal : Waterberg, Warm Baths (*Distant*).

Described from one male and two female specimens of the dark form, and two female specimens of the pale form, which may possibly prove to be distinct when the genus is better known.

There appear to be several species of *Chrotogonus* allied to *C. hemipterus*, Schaum, the description and figure of which were probably taken from specimens bleached by spirit. I am not sure that it has yet been satisfactorily identified.

### 51. *Chrotogonus rendalli*, sp. n.

Long. corp. cum tegm. 19–20 millim.

Very similar to the last species, but rather narrower, and with the orange markings almost obsolete. Colour brownish-grey, mottled with blackish on the thorax. Front edge of prothorax with two black central tubercles ; hinder edge with two large ones on each side of the central line, and one or two smaller ones in addition. Face,

pleura, hinder lobe of prothorax, and base of hind femora paler grey than the rest of the insect ; pleura with one or two distinct black spots. Tegmina oblong, extending distinctly beyond the pale smooth basal half of the first segment of the abdomen, rounded off on the outer end, but slightly pointed at the inner end, which is not the case in *C. distanti*.

*Hab.* NYASALAND: Fort Johnston (*Rendall*).
Described from three female specimens and one male.

### 52. *Chrotogonus carinatus*, sp. n.

Long. corp. 22–23 millim.

*Female*. Dark brown, thorax thickly studded with black tubercles, and with several large projecting angles on the sides. Front lobe of prothorax carinated in the middle ; hinder lobe with two conspicuous black tubercles on each side of the median line at the extremity, beyond which is a well-marked carina. Tegmina narrow, almost sickle-shaped, the points meeting on the median line at the extremity of the first segment of the abdomen. Legs reddish, slightly mottled with black, tarsi and tips of tibiæ black. Tubercles of the abdomen concolorous.

*Hab.* NYASALAND: Zomba, Fort Johnston (*Rendall*).
Described from two specimens.

### 53. *Chrotogonus rotundatas*, sp. n.

Long. corp. cum tegm. 20–23 millim.

Dark brown, mottled with blackish ; head and thorax thickly rugose and granulated ; antennæ pale, banded with black in the male, nearly black in the female ; frontal carinæ narrow, subparallel ; pronotum not raised in lobes, not much produced, and regularly rounded behind, where it is slightly carinated. On the hinder edge are two large black tubercles on each side, between the median carina and the black lateral carinæ, and lower, the sides are bordered behind with smaller ones. Face, and sides of body whitish, under-surface yellowish, with the usual rows of black spots on the abdomen. Face with strong lateral carinæ, and with a few large tubercles at the back of the cheeks, one on each side, in the male, being conspicuously yellow. Hind femora reddish-brown, more or less varied with whitish, and mottled with black ; a double black line about the middle above, and the lower carinæ spotted with black, the inside with a black longitudinal stripe. Tegmina with one

central row of granules, and extending for ¼ of their length beyond the abdomen.

*Hab.* NYASALAND: Fort Johnston (*Rendall*).

Described from two specimens, ♂ and ♀. Apparently allied to *C. fumosus*, Bolivar.

### 54. *Chrotogonus johnstoni*, sp. n.

Long. corp. cum tegm. 21–23 millim.

Resembles *C. capitatus*; reddish-brown, mottled with blackish; head and thorax strongly rugose and granulated, the three lobes of the pronotum, seen from the side, much higher, the second shorter than the others, an oblique lateral carina on the hinder lobe opposite the base of the tegmina; legs rather irregularly banded with paler and darker; hind femora with a blackish band about the middle above, preceded by a broader paler band; inner side black, extremity and lower carina yellowish, the latter spotted with black; hind femora black, with two yellow bands; hinder lobe of pronotum much produced, broadly rotund-truncate at the extremity; tegmina brown, not granulated, irregularly and rather indistinctly banded and spotted with darker; ⅛ longer than the abdomen. Frontal carinæ broad, undulating, extending to within the eyes. Undersurface of the abdomen more thickly and irregularly spotted with black than in the allied species.

*Hab.* NYASALAND: Fort Johnston, Zomba (*Rendall*).

Described from one male and two female specimens.

## *ATRACTOMORPHINÆ.*

### Genus ATRACTOMORPHA.

*Atractomorpha*, Saussure, Ann. Soc. Ent. France (4), i, p. 474 (1861); Bolivar, An. Soc. Esp., xiii, p. 63 (1884).

*Perena*, Walker, Cat. Derm. Salt., iii, p. 506 (1870), v, Suppl., p. 50 (1871).

### 55. *Atractomorpha aurivillii.*

*Atractomorpha aurivillii*, Bolivar, An. Soc. Esp., xiii, p. 67, pl. i, fig. 8 (1884).

*Hab.* TRANSVAAL: Pretoria (*Distant*); NYASALAND: Fort Johnston (*Rendall*).

*PYRGOMORPHINÆ.*

Genus Pyrgomorpha.

*Pyrgomorpha*, Serville, Ins. Orth., p. 583 (1839); Bolivar, An. Soc. Esp., xiii, p. 76 (1884).

56. *Pyrgomorpha granulata.*

*Pyrgomorpha granulata*, Stal, Bihang Vet. Akad. Handl., iii (14), p. 26 (1875); Œfv. Vet. Akad. Förh., xxxiii (3), p. 32 (1876); Bolivar, An. Soc. Esp., xiii, p. 426 (1884).

*Hab.* Transvaal: Pretoria, Rustenburg (*Distant*); Nyasaland: Fort Johnston (*Rendall*).

Except in the position of the eyes, the shorter and less pointed tegmina, and the different colour of the wings, this species has much resemblance to *Atractomorpha auricillii*, Bol.

Genus Ochrophlebia.

*Ochrophlebia*, Stal, Rec. Orth., i, pp. 10, 14 (1873); Bolivar, An. Soc. Esp., xiii, p. 430 (1884).

57. *Ochrophlebia ligneola.*

*Pœciloceras ligneolus*, Serv., Ins. Orth., p. 602 (1839).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*), Zoutpansberg (*Kaessner*).

*PHYMATINÆ.*

Genus Zonocerus.

*Zonocerus*, Stål, Œfv. Vet. Akad. Förh., xxx, p. 51 (1873); Rec. Orth., i, pp. 10, 16 (1873); Bolivar, An. Soc. Esp., xiii, p. 457 (1884).

58. *Zonocerus elegans.*

*Gryllus elegans*, Thunberg, Mém. Pétersb., v, p. 226 (1815), ix, p. 407, pl. xiv, fig. 2 (1824).

*Zonocerus elegans*, Stål, Rec. Orth., i, p. 17 (1873); Œfv. Vet. Akad. Förh., xxxiii (3), p. 33 (1873); Bolivar, An. Soc. Esp., xiii, p. 459, pl. 3, fig. 19, 19a. (1884).

*Pœkilocerus roscipennis*, Serville, Ann. Sci. Nat., xxii, p. 276, n. 3 (1831); Ins. Orth., p. 599 (1839).
Var. *Pœcilocera atriceps*, Gerstaecker, Arch. f. Nat., xxxv, p. 216 (1869); Von der Decken's Reisen in Ost-Afrika, iii (2), p. 36 (1873).
*Zonocerus atriceps*, Bolivar, An. Soc. Esp., xiii, p. 458 (1884).

*Hab.* TRANSVAAL: Zoutpansberg (*Kaessner*); DELAGOA BAY (*Dawson*); East London, CAPE; ZULULAND; NATAL; KILIMANJARO; BRITISH EAST AFRICA (Brit. Mus.).

*Z. atriceps*, Gerst., is, I think correctly, referred to this species by Dr. Karsch. The characters given by various authors, to distinguish it from *Z. elegans*, Thunb., are not satisfactory; and it appears to be founded on yellow (or perhaps faded ?) specimens of the micropterous form. The red micropterous form of *Z. elegans* is figured by Bolivar.

### 59. *Zonocerus sanguinolentus.*

*Acrydium sanguinolentum*, De Geer, Mém. Ins., iii, p. 489, n. 5, pl. 40, fig. 9 (1773).
*Pœkilocerus sanguinolentus*, Serville, Ins. Orth., p. 598 (1839).
*Zonocerus variegatus*, Stål, Rec. Orth., i, p. 16 (1873); Bolivar, An. Soc. Esp., xiii, p. 450 (1884).

*Hab.* ANGOLA (*Monteiro*); NATAL; ZOMBA; SIERRA LEONE; CAMEROONS; NIGER; ASHANTI, etc. (B. M.).

I am not satisfied that this species is correctly identified with *Gryllus* (*Locusta*) *variegatus*, Linnæus, the type of which is lost.

## Genus PHYMATEUS.

*Phymateus*, Thunberg, Mém. Pétersb., v, p. 257 (1815); Serv., Ins. Orth., p. 624 (1839); Stål, Rec. Orth., i, pp. 11, 17 (1873); Bolivar, An. Soc. Esp., xiii, p. 461 (1884).

### 60. *Phymateus leprosus.*

*Gryllus leprosus*, Fabricius, Ent. Syst., ii, p. 51, n. 18 (1793).
*Phymateus leprosus*, Stål, Rec. Orth., i, p. 18 (1873); Bolivar, Ann. Soc. Esp., xiii, p. 463, pl. 3, fig. 21 (1884).

*Hab.* Transvaal: Barberton (*Rendall*); Beaufort West, Cape Colony (*Distant*); Natal (B. M.).

61. *Phymateus papillosus.*

*Dictyophorus papillosus*, Thunberg, Mém. Acad. Pétersb., v, p. 258 (1815).
*Gryllus* (*Locusta*) *morbillosus*, Houttuyn, Nat. Hist., i (10), p. 218, n. 42, pl. 80, fig. 5 (1766).
*Gryllus Locustæ morbillosi Nympha*, Stoll, Saut., pl. 6 B. fig. 21 (1813).

*Hab.* Transvaal: Pretoria (*Distant*).

This insect is apparently not the nymph of *P. morbillosus*, as every author since the time of Houttuyn seems to have inferred. I cannot refer it to any perfect insect before me; but it is probably most nearly allied to *P. leprosus*, Fabr., though smaller, and differently coloured. There are specimens of a similar pupa in the British Museum, also without any perfect insect to correspond to them.

61a. *Phymateus ægrotus.*

*Pœciloscerus ægrotus*, Gerst., Arch. f. Nat., xxxv, p. 216 (1869); Von der Decken, Reisen, iii (2), p. 35 (1873).
*Phymateus ægrotus*, Bolivar, An. Soc. Esp., xiii, p. 465 (1884).
*Phymateus squarrosus*, Distant, Nat. Transv., p. 259 (1892): (*nec* Linn.).

*Hab.* Pretoria (*Distant*); Angola (*Monteiro*); Brit. Central Africa: Zomba (*Rendall*); Caffraria (*Wahlberg*); Abyssinia (*Raffray*); Somali (*Gerstæcker*); Tanganyika; Kilimanjaro; Fwambo; Nyasaland; Natal; Zululand (B. M.).

A common species. The spines bordering the pronotum may be either red or green. Stoll has figured an allied species (*P. stolli*, Sauss.) as *squarrosus*, Linnæus, but the latter is a West African insect belonging to the allied genus *Rhytidoderes*, Westwood (*Peristegas*, Bolivar).

62. *Phymateus morbillosus.*

*Gryllus* (*Locusta*) *morbillosus*, Linnæus, Syst. Nat. (ed. x.), p. 431, n. 1 (1758); Mus. Ludov. Ulr., p. 141 (1764).

*Phymateus morbillosus*, Stål, Rec. Orth., i, p. 18 (1875); Bolivar, An. Soc. Esp., xiii, p. 467 (1875).

*Hab.* NAMAQUALAND.
A well-known South African species.

*DICTYOPHORINÆ.*

Genus TAPHRONOTA.

*Taphronota*, Stål, Œfv. Vet. Akad. Förh., xxix, p. 51 (1873): Rec. Orth., i, pp. 11, 15 (1873); Bolivar, An. Soc. Esp., xiii, p. 473 (1884).

63. *Taphronota calliparcus.*

*Pœcilocerus calliparcus*, Schaum, Monatsb. Berl. Acad., 1853, p. 778; Peters' Reise Mossamb. Zool., v, p. 130, pl. vii A, fig. 2 (1862).
*Taphronota calliparea*, Bolivar, An. Soc. Esp., xiii, p. 475 (1884).
*Pœcilocerus porosus*, Stål, Œfvers. Vet. Akad. Förh., xiii, p. 352 (1855).
*Taphronota porosa*, Stål, Rec. Orth., i, p. 19 (1873).

*Hab.* TRANSVAAL: Barberton (*Distant*); NYASALAND: Fort Johnston (*Rendall*); PEMBA ISLAND (*Burtt*); CAFFRARIA (*Stål*); MOZAMBIQUE (*Peters*); NATAL; ZULULAND: TANGANYIKA; ZOMBA; CAMEROONS (B. M.).

64. *Taphronota ståli.*

*Taphronota ståli*, Bolivar, An. Soc. Esp., xiii, p. 473 (1884).

*Hab.* TRANSVAAL: Pretoria (*Distant*), Barberton (*Rendall*); NATAL (B. M.).
Bolivar describes this insect as green; but in all the specimens before me the pronotum is black, though the head is often more or less green.

Genus MAURA.

Stål, Œfv. Vet. Akad. Förh., xxx, p. 51 (1873); Rec. Orth., i, pp. 12, 19 (1873); Bolivar, An. Soc. Esp., xiii, p. 478 (1884).

65. *Maura rubroornata.*

*Petasia rubroornata*, Stål, (Efv. Vet. Akad. Förh. (1855), p. 352; Rec. Orth., i, p. 19 (1873).
*Maura rubroornata*, Bolivar, An. Soc. Esp., xiii, p. 480 (1884).
*Petasia pyrrhomela*, Walker, Cat. Derm. Salt. B. M., iii, p. 545, n. 4 (1870).

*Hab.* Transvaal: Pretoria (*Distant*), Zoutpansberg (*Kaessner*); Caffraria (*Stål*); Zululand; Cape (B. M.).

66. *Maura atriceps*, sp. n.

Long. corp. 34 millim.; exp. al. 60 millim.

Blue-black; antennæ with two red bands, occupying joints 7 and 8, and 11, 12, and the base of 13. Head quite black, except that the ocelli are very slightly marked with pale yellow. There is a buff mark above the four hinder coxæ, and a buff mark below the front coxæ. A broad transverse band on the metapectus, lateral bands on the first six segments of the abdomen (connected dorsally by yellow lines at the ends of the segments), narrower terminal lines on the six corresponding ventral segments, the cerci, and a spot on each side towards the extremity of the hind femora, red; tegmina dark brown, wings more grey.

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*).

The specimen from Barberton differs in having a red spot beneath the wings, as in *M. rubroornata*, and in having a red spot on the outside only of the hind femora, near the base.

67. *Maura flavomaculata*, sp. n.

Perhaps a variety of *M. atriceps*, with which it mainly agrees in size, colour, and markings, except that all the pale markings are pale yellow, instead of red, only those on the under-surface of the abdomen being slightly tinged with reddish. Antennæ with two bands; lower part of clypeus with a broad yellow transverse band on each side. Pectus and abdomen similarly marked, but there is a round yellow spot on the pleura (only present in red in the Barberton variety of *M. atriceps*), and the pale bands on the under-surface of the abdomen are much broader than in *M. atriceps*. Hind femora with a round spot near the

base, and a smaller and more irregular one near the extremity, towards the upper carina, but on the outer side only. Tegmina and wings as in *M. atriceps*; a large pale spot above the hind coxæ.

*Hab.* Transvaal: Sterkfontein (*Thomasset*).
In the collection of the British Museum.

### 68. *Maura bolivari*, sp. n.

Long. corp. 30 millim.

*Female.* Dark reddish-brown, mottled with black; head and thorax rugose above, scutellum of vertex thickly punctured; antennæ black, the penultimate joint and sometimes the one preceding it red; face and lower part of head shining black, except a broad luteous band, covering the greater part of the clypeus, except near the eyes, and the middle of the base of the labrum; tegmina abbreviated, reaching nearly to the end of the third segment of the abdomen; a large rufous spot below their base, on the metapleura; pronotum rounded behind; hind femora black inside and below, mottled with reddish and black on the outside, and the inner carina above yellowish, interrupted with black. Abdomen more or less mottled with red and black above; beneath black banded with red.

*Hab.* Nyasaland: Fort Johnston (*Rendall*); Zomba (B. M.).

Named after the eminent Spanish Orthopterist, Señor I. Bolivar.

### Genus Epamontor, g. n.

*Male.* Scutellum of the vertex as long as the large oval eyes; seen from above, ovally rounded in front, but surmounted by two lateral carinæ running within the eyes, nearly meeting in front in an acute angle; head, thorax, and abdomen, with a well-marked median carina, ceasing a little in front of the eyes, where it is followed by a sulcation extending to the front; antennæ placed near the eyes, below the lateral ocelli; antennæ fusiform, about 17-jointed, the joints of the flagellum mostly short, transverse, cheese-shaped; all parts of the body marked with yellow granules, in more or less regular longitudinal rows; pronotum truncated and slightly raised behind; cerci stout, conical, a little shorter than the terminal joint of the abdomen; legs long and slender; hind femora unarmed, slightly and gradually attenuated towards the extremity, and nearly as long as the abdomen; hind tibiæ about as long as the hind femora, with

a double row of moderate-sized spines above. Abdomen with a carina regularly arched on each segment.

This insect appears to be allied to the genus *Maura*. It is perhaps a larval form, but does not agree sufficiently with any specimen before me to be placed in the same genus.

69. *Epamontor antennalis*, sp. n.

Long. corp. 16 millim.

*Male*. Rufo-testaceous, darkest on the head and thorax, set with yellow tubercles, of which the largest are a pair on the back, and an oblong one on each side, at the base of the pronotum ; while on the abdomen the spots forming the lowest row on the sides are the largest. Antennæ black, the whole of joint 13, and the under-surface of the following ones to the tip, rufous. Head black, dotted with yellow ; scutellum of the vertex, below the lateral carinæ, palpi, pectus, under-surface of the abdomen, and cerci, rufous. Legs more or less varied with reddish or yellowish, and black, and dotted with yellow ; lower carinæ of the hind femora yellow, interrupted with black.

*Hab.* Transvaal : Pretoria (*Distant*).
Described from two specimens.

Genus Dictyophorus.

*Dictyophorus*, Thunberg, Mém. Pétersb., v, p. 258 (1815).
|| *Petasia*, Serville (*nec* Stephens), Ann. Sci. Nat., xxii, p. 278 (1831); Ins. Orth., p. 628 (1839); Stal, Rec. Orth., i, pp. 12, 20 (1873); Bolivar, An. Sci. Esp., xiii, p. 481 (1884).

Thunberg included three species under this name: *D. spumans, papillosus*, and *reticulatus*. *D. reticulatus* is congeneric, if not identical, with *Acridium micropterum*, Beauvois, the type of *Romalea*, Serville (*Rhomalea*, Burmeister); and *D. papillosus* is apparently an immature insect belonging to the genus *Phymateus*, Thunberg. This leaves the first species (and therefore *ipso facto* the type, in the view of some entomologists; though when I raised the question years ago at the Entomological Society, the suggestion was rejected), *D. spumans*, as the type of *Dictyophorus*; more especially as it is the type of Serville's later and preoccupied genus *Petasia*, which could not be retained in any case.

### 70. *Dictyophorus ater.*

*Petasia spumans*, var. *ater*, Dist., Naturalist in Transvaal, p. 259, pl. iv, fig. 3 (1892).

*Hab.* Transvaal: Pretoria (*Distant*).

A well-marked form, and perhaps a good species. The true *D. spumans*, Thunb. ( = *cruentata*, Serv.), does not appear to occur in the Transvaal.

### 71. *Dictyophorus olivaceus.*

*Petasia olivacea*, Serville, Ann. Sci. Nat., xxii, p. 279, n. 2 (1831).
*Petasia cruentata*, var., Serville, Ins. Orth., p. 630 (1839).

*Hab.* Transvaal: Barberton (2 specimens: *Rendall*), Pienaar's River (1 specimen: *Thomsen*).

There appear to be several species confounded under the name of *P. spumans*, Thunb. If, as I presume, the latter is the red insect figured by Roesel and Stoll, and described by Serville as *P. cruentata*, there are no specimens in Mr. Distant's collection. The three specimens referred to *P. olivacea* agree fairly well with Serville's description, quoted above, which, however, is very incomplete.

## *PAMPHAGODINÆ.*

### Genus Charilaus.

*Charilaus*, Stål, Bihang Vet. Akad. Handl., iii (14), p. 26 (1875); Œfv. Vet. Akad. Förh. xxxiii (3), p. 35 (1876); Bolivar, An. Soc. Esp., xiii, p. 487 (1884).

### 72. *Charilaus carinatus.*

*Charilaus carinatus*, Stål, Bihang Vet. Akad. Handl., iii (14), p. 26 (1875); Œfv. Vet. Akad. Förh., xxxiii (3), p. 35 (1876); Bolivar, An. Soc. Esp., xiii, p. 488, pl. iv, figs. 30, 30a (1884).

*Hab.* Transvaal: Waterberg, Warm Baths (*Distant*); Damaraland (*Stål*).

A single specimen of this rare and curious species.

*PAMPHAGIDÆ.*

Genus ADEPHAGUS.

*Adephagus*, Saussure, Spic. Ent., ii, p. 23 (1887).

73. *Adephagus cristatus.*

*Pamphagus cristatus*, Burmeister, Handb. Ent., ii, p. 618, n. 10 (1838).

*Adephagus cristatus*, Saussure, Spic. Ent., ii, p. 23, n. 1, pl. 3, fig. 22 (1887).

*Hab.* TRANSVAAL (*Saussure*).

Genus XIPHICERA.

*Xiphicera*, Lamarck, Anim. sans Vertèbres, iv, p. 243 (1817).

*Xyphicera*, Latreille, Cuvier, Règne Anim., v, p. 186 (1829).

*Xiphocera*, Stal (*nec* Burmeister), Efv. Vet. Akad. Förh., xxxiii (3), p. 37 (1876); Saussure, Spic. Ent., ii, pp. 19, 27, 30, 35 (1887).

So much confusion exists in the use of the names *Xiphicera* and *Xiphocera* that I think it well to discuss the whole subject in detail, especially as the particulars given in my paper on "The Genera of Orthoptera," published in the *Journal of the Royal Dublin Society* for 1890, are incomplete.

1815. *Pamphagus*, Thunberg, Mém. Pétersb., v, p. 260.

Several species are included under this name, including *Gryllus elephas* and *serripes*, Fabr., and *virens*, Thunb.

1839. Burm., Handb. Ent., ii, p. 615, includes *inter alia*, *G. serripes*, F., *virens*, T., and *elephas*, Linn.

1873. Stål, Rec. Orth., i, pp. 21, 25.

Stal designates *G. elephas*, Linn. (*nec* Fabr.), as the type, which may be accepted; as *G. virens*, Thunb. (accidentally omitted from the list in my Dublin paper, of which I did not see a revise), is considered to be the same species.

1817. *Xiphicera*, Lamarck, Anim. sans Vert., iv, p. 243.

Types, *Gryllus gallinaceus* and *serripes*, Fabr. (the latter = *carinatus*, Linn.).

1829. *Xyphicera*, Latreille, Cuvier, Règne Anim. (ed. 2), v, p. 186.

Types, *Gryllus carinatus*, Linn., and *G. gallinaceus*, Fabr.

1831. *Xiphicera*, Serville, Ann. Sci. Nat., xxii, p. 271.

Types, *X. emarginata* and *trilineata*, Serv.

These species belong to the family *Cyrtacanthacridæ*, and to the American subfamily *Tropinotinæ*, and have nothing to do with the types of Lamarck and Latreille.

1839. *Xiphocera*, Burmeister, Handb. Ent., ii, p. 612.

Used by Burmeister in Serville's sense, for various American species of the allied subfamily *Tetratæniinæ*. The name cannot, however, be retained in the form *Xiphocera*, for *Xiphocera* was used by Macquart in 1834 for a genus of Diptera, and has also been used by later Dipterists under the various forms of *Xiphocera*, *Xiphocerus*, *Xyphidicera*, *Xyphocera*, and *Xyphocerus*.

1876. *Xiphocera*, Stal (*nec* Burmeister), Œfv. Vet. Akad. Förh., xxxiii (3), p. 37 (1876); Saussure, Spic. Ent., ii, pp. 19, 27, 30, 35 (1887).

The types given by Lamarck for *Xiphicera* are *G. gallinaceus* and *serripes*, Fabr., for the latter of which Latreille substitutes *carinatus*, L. The genus is distinguished by its Truxaliform antennæ, which at once throws out *G. gallinaceus*, which is one of the *Mastacidæ*. Nor is the character well marked in *G. carinatus*, of which *G. serripes* is usually considered a synonym; but it is pronounced in *G. cucullatus*, Stoll, which is described by Serville under the name of *carinatus*; and we are therefore justified in regarding *cucullatus* as the insect which Lamarck and Latreille regarded as *G. serripes* or *carinatus*, and therefore as the true type of the genus *Xiphicera*.

1831. *Porthetis*, Serville, Ann. Sci. Nat., xxii, p. 270.

Type *Acrydium dentatum*, De Geer (= *Gryllus carinatus*, Linn.).

If we assume that Lamarck and Latreille had correctly identified *G. carinatus* and *G. serripes*, *Porthetis* would become a synonym of *Xiphicera*, and a new name would be required for G. *canescens* and its allies; but as the identification is doubtful, both generic names may be retained, at least provisionally.

The genus *Xiphicera* itself will require further subdivision; but our knowledge of the sexes, variation, etc., is too limited to render it advisable to attempt it at present. In the case of species with extended synonymy, only the most important references are quoted; but these will always include a reference to some author who gives the full synonymy.

### 74. *Xiphicera cucullata.*

*Gryllus cucullatus*, Stoll, Sauterelles, pl. 22b, figs. 96, 97 (1815).
*Pamphagus cucullatus*, Burmeister, Handb. Ent., ii, p. 616, n. 1 (1839).
*Pamphagus canescens*, Thunberg, Hemipt. Max. Cap., p. 5 (1822).
*Porthetis canescens*, Stål, Rec. Orth., i, p. 24 (1873); Saussure, Spic. Ent., ii, p. 37, pl. ii, figs. 2–4 (1887).
*Akicera carinata*, Serville (*nec* Linnæus), Ins. Orth., p. 605 (1839).

*Hab.* Transvaal: Pretoria (immature), Masil. Nek (*Distant*), Waterberg (*Wildes*), Teafontein (*Miss Leppa*, Oct., 1894), Barberton (*Rendall*).
Previously recorded from the Transvaal by Saussure.

### 75. *Xiphicera ensicornis.*

*Xiphoccra ensicornis*, Saussure, Ent. M. Mag., xxix, p. 152 (1893).

*Hab.* Transvaal: Zoutpansberg (*Distant*); Lydenburg (*Zurtz*).
One of the two specimens of *Akicera punctosa*, Walker, in the Brit. Mus., apparently belongs to this species. The type of *punctosa*, however, is a slightly larger insect, with the vertex of the scutellum longer in proportion, and with larger medial spines on the abdomen. But I am not quite satisfied that the specimens are not varieties of one and the same species.

### 76. *Xiphicera nasuta.*

*Xiphoccra nasuta*, Saussure, Spicil. Ent., ii, p. 47, pl. ii, fig. 6 (1887).

*Hab.* Transvaal: Barberton (*Rendall*); Murchison Range (B. M.); Zululand (*Saussure*).

The male (not described by Saussure) is 38 millim. in length, or 46 to the extremity of the closed wood-brown tegmina. The front is rather prominent, and the scutellum of the vertex forms a long oval, with converging lateral carinæ, and a slight median carina behind. The head and prothorax are longitudinally striped with black and testaceous, and there is a very characteristic testaceous stripe, meeting in front, and running backwards below the eye to a point, before reaching the hinder edge of the prothorax. The antennæ are black, with the two basal joints, and more or less of the five terminal joints, testaceous. The female from Barberton is much greyer, with the abdomen brown. In the female from Murchison Range, the flattened portion of the antennæ and the lower part of the face are reddish, instead of black.

### 77. *Xiphicera eblis*, sp. n.

Long. corp. 55 millim.

*Female.* Very dark chestnut, approaching black on some parts of the head; head and thorax moderately thickly speckled with white, the rest of the body more sparingly; vertex considerably produced above the lower part of the face; scutellum of the vertex forming a long oval, with lateral carinæ behind, curving inwards; head and thorax with longitudinal ill-defined blackish marks; face thickly dusted with white, forming an ill-defined pointed stripe backwards under the eye, as described in the male of *X. nasuta*. Antennæ 14-jointed, black, except the two basal, and the terminal joints; joints 3–7 very broad and flattened, joints 8 and 9 scarcely narrower, the last five much narrower, the last longest, and conical. Thorax moderately arched, the hinder part with rounded crenulations, the extremity somewhat obtuse. Abdomen with the usual teeth on the median carina, short and obtuse on the second and third segment, scarcely marked on the others. Hind femora moderately long and broad, slightly dentated above, but merely tuberculate and sinuated below. Hind tibiæ with ten spines on the outer carina, the space between the carinæ filled up with whitish hair.

*Hab.* Transvaal: Pretoria (*Distant*).

Closely allied to *X. punctosa*, Walk., etc., but differs from any other species in the shape of the antennæ.

78. *Xiphicera angolensis* (?).

*Xiphocera angolensis*, Saussure, Spic. Ent., ii, p. 47, pl. i, fig. 8 (1887).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*).

A series of immature specimens, apparently more resembling this species than any other.

79. *Xiphicera cinerascens*.

*Pamphagus cinerascens*, Stal, Rec. Orth., i, p. 23 (1873).

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*).

Many specimens from Pretoria of this large and handsome species, representing both sexes, and also larval forms. One male exhibits a peculiar malformation of the right antenna, which is only half the length of the other, and consists of about eight malformed joints.

80. *Xiphicera rugosipes*, sp. n.

Long. corp. 60–65 millim.

*Female*. Very rugose and nodulose. Antennæ 16-jointed, scape thick, twice as long as broad, distinctly granulated; second joint annular, joints 3–8 moderately broad and flattened, ribbon-like, joints 4 and 5 the shortest, the last six joints much narrower, and distinctly separated; joint 11 the shortest, nearly square, joint 13 half as long again; the others longer. Vertex seen from the side nearly on a level with the lower part of the face; scutellum of the vertex slightly depressed and rectangular in front, the extremities of the angle projecting somewhat beyond the lateral carinæ, in front of the eye; the lateral carinæ curving round in front of the occiput. Colour rufo-testaceous, varied with paler and darker, indistinctly striated with blackish, and covered with whitish granules. Crest of the pronotum moderately arched, the hinder part strongly granulated, both on the median line and on the outside; terminal carinæ yellowish. All the pleuræ strongly serrated above each pair of legs. Abdomen with a strong tooth on each segment on the median line, and with a row of tubercles on each side. The whole thorax and abdomen are very rugose, and strongly granulated. Hind femora shaped as in *X. latipes*, strongly granulated and tuberculated, the central area reticulated with black. Upper carina strongly serrated, the hinder part somewhat raised beyond the

deepest notch. Lower carina with a double row of crowded and irregular teeth and tubercles, and with a very large tubercle about the middle. Internal area of the hind femora nearly smooth. Hind tibiæ with nine spines in the outer carina.

*Hab.* Transvaal: Pretoria (*Distant*), Barberton (*Rendall*); Delagoa Bay (*H. A. Spencer*).

Described from three female specimens. This species is something like *X. cinerascens*; but I can find no species described which resembles it in its rugosity, and in the peculiar structure of the hind femora.

### 81. *Xiphicera paupercula*, sp. n.

Long. corp. 43 millim.

*Female.* Dark reddish-brown; legs paler; head, thorax and hind legs thickly granulated with white; vertex only slightly projecting beyond the lower part of the face; scutellum of the vertex rounded off in front, nearly horizontal, coarsely and finely granulated, the lateral carinæ converging behind. Antennæ short and broad, 14-jointed, rather flattened, joints 3–8 flattened, closely connected, pairs 9 and 10 and 11 and 12 successively narrower, but 9 and 11 shorter than 10 and 12, and 13 narrower but a little longer than 12; terminal joint twice as long as broad; conical. Thorax compressed, crest regularly arched, with three deep concavities beneath it; hinder part of crest denticulated, with the extremity bifid. Abdomen very rugose, median teeth large, and a row of rather large callosities on each side as well. Hind femora very broad, extremity truncated, preceded by a large concavity beneath. Hind femora strongly dentated above, and irregularly denticulated below, and with nine spines on the outer carina.

*Hab.* Transvaal: Pretoria (*Distant*).

This insect seems to combine the characters of *X. distanti* and *X. rugosipes*, but the scutellum of the vertex is more rounded in front, and the antennæ differ much. It is, however, not quite impossible that it may be an immature form of *X. rugosipes*.

### 82. *Xiphicera distanti*.

*Xiphocera distanti*, Saussure; Dist., Nat. Transv., p. 261, pl. iv, fig. 1 (1892).

*Hab.* Transvaal: Pretoria (*Distant*).

Several specimens. The male has rather pointed rudimentary wings extending just beyond the third segment of the abdomen.

### 83. *Xiphiccra picta.*

*Xiphocera picta*, Saussure; Dist., Nat. Transv., p. 261, pl. iv, fig. 2 (1892).

*Hab.* Transvaal: Pretoria, Waterberg and Rustenburg (*Distant*).

This species seems to vary considerably, but I have not felt justified in describing any of the forms before me as new. The male has rudimentary wings.

### 84. *Xiphiccra compressa*, sp. n.

Long. corp. 45 millim.; capitis et pronoti 24 millim.

*Male.* Antennæ short, 14-jointed; ensiculus 6-jointed, moderately broad, intermediate joints transverse, the first only half as long as the second; flagellum 4-jointed, the two first joints flattened, narrower than the intermediate joints, and slightly broader than long; the two last cylindrical. Vertex not produced beyond the lower part of the face; scutellum of vertex rather longer than broad, subrectangular in front, but obtusely rounded off; lateral carinæ converging behind. Head and pronotum grey, head below, and pronotum above and below darker. Pronotum very long, considerably compressed, but not pitted above; slightly sinuated beyond the middle, but not dentated; extremity shortly bifid. The whole insect, except the basal and apical joints of the antennæ, the sides, under-surface, and neighbourhood of the sutures of the abdomen—which are brown—and the spines and tarsi of the legs, is more or less thickly covered with white granules; on the sides of the hinder part of the prothorax are some larger concolorous tubercles. Wings extending to the middle of the third segment of the abdomen, rufo-testaceous, with black dots along the longitudinal nervures. Hind femora about three times as long as broad, carinæ subparallel, the lower one slightly concave before the knee, denticulated above, and more slightly below; hind tibiæ with nine spines on the outer carina.

*Hab.* Transvaal: Pretoria (*Distant*).

Described from two specimens, one considerably darker than the other. The lighter specimen, has been selected as the type. Somewhat resembles *X. brevis*, Walk., in shape,

but much less rugose, and the shape of the antennæ is quite different. Probably allied to *X. obsoleta*, but can hardly be the male of that species.

### 85. *Xiphicera granulosa*, sp. n.

*Female.* Antennæ 15-jointed, basal joints red, joints 3–8 black, forming an ensiculus, slightly flattened, but scarcely broader than the rest; joints 9–11 also black, more distinctly separated; joint 9 shorter than the two following ones; joints 12–15 reddish, the last cylindrical, and nearly as long as the two preceding ones together; body brown, thickly granulated with white, and with larger granules scattered on the sides of the thorax and abdomen; space behind and below the eyes a little greenish; vertex hardly projecting beyond the lower part of the face; scutellum of the vertex nearly as broad as long, forming a rectangle in front, not rounded off, and the lateral carinæ semicircular behind; pronotum sharply pointed in front, crest nearly straight, yellowish, not carinated, but strongly bifid at the extremity; spines of the abdomen large; hind femora narrowed above and below before the knee, strongly dentated above, and denticulated below; crest of pronotum with three semivitreous cavities below.

*Hab.* Transvaal: Pretoria (*Distant*).

Allied to *X. compressa*, and possibly the female of that species.

### 86. *Xiphicera brevis.*

*Pamphagus brevis*, Walker, Cat. Derm. Salt., iii, p. 534, n. 3 (1870).

*Hab.* Transvaal: Pretoria (*Distant*); Natal (*type*) (*Gueinzius*).

### 87. *Xiphicera obsoleta*, sp. n.

Long. corp. 50 millim.

*Female.* Dark brown, nearly black, granulated. Antennæ 14-jointed, joints 3–8 moderately broad, and so closely connected that they can hardly be counted; joints 9 and 10 flattened, but narrower, and joint 9 shorter than 10; the rest cylindrical, 11 and 12 shorter than 13 and 14. Prothorax with the median and all the bordering carinæ slightly reddish; the upper two-thirds of the front more reddish, with traces of three blackish longitudinal lines in front, below the crest. Crest moderately arched, and somewhat sloping

behind, where it is denticulated. Abdomen with strong spines on the median line on the first seven segments. Hind femora very broad and truncated at the extremity, the carinæ paler; upper carinæ moderately dentated, lower carinæ denticulated. Hind tibiæ with nine spines on the outer carina.

*Hab.* Transvaal: Pretoria (*Distant*).

Differs from *X. femoralis*, Walk., and *X. latipes*, Sauss., in colour, the well-marked abdominal spines, the armature of the hind femora, etc.

### 88. *Xiphicera rendalli*, sp. n.

Long. corp. 45 millim.

*Female.* Dark reddish-brown, darker in the back, longitudinally marked on the sides with waved, but rather indistinct blackish lines. Antennæ very long, 16-jointed; two basal joints red, the rest black; ensiculus moderately broad, flattened, 7-jointed; intermediate joints, first pair of joints of flagellum and second pair successively narrowed, but scarcely decreasing in length; terminal joint cylindrical, longer than any preceding. Vertex hardly projecting beyond the lower border of the face; pronotum somewhat rugose, crest regularly and moderately arched, slightly crenulated towards the extremity, which is simple. Hind femora contracted above and below before the knee, strongly dentated above, and denticulated beneath.

*Hab.* Transvaal: Barberton (*Rendall*).

Resembles Saussure's figure of *X. mannulus*, but the structure of the antennæ is quite different.

### 89. *Xiphicera bradyana*.

*Xiphocera bradyana*, Saussure, Spic. Ent., ii, p. 55, n. 17, pl. ii, fig. 1 (1887).

*Hab.* Transvaal (*Saussure*); South Africa (B. M.).

Not in Mr. Distant's collection.

## Genus Porthetis.

*Porthetis*, Serville, Ann. Sci. Nat., xxii, p. 270 (1831); Stål, Rec. Orth., i, pp. 21, 23 (1873); Öfv. Vet. Akad. Förh., xxxiii (3), p. 37 (1876); Saussure, Spic. Ent., ii, pp. 33, 60 (1887).

90. *Porthetis carinata.*

*Gryllus* (*Bulla*) *carinatus*, Linnæus, Syst. Nat. (ed. x), i, p. 427, n. 16 (1758); Mus. Ludov. Ulr., p. 122 (1764).
*Porthetis carinata*, Stal, Rec. Orth., i, p. 23, n. 2 (1873).
*Xiphocera carinata*, Saussure, Spic. Ent., ii, p. 60, pl. iii, fig. 13 (1887).

*Hab.* Transvaal (*Saussure*); Cape Colony.
Not in Mr. Distant's collection.
I refer to Stål and Saussure for the complicated synonymy of this species.

91. *Porthetis consobrina.*

*Xiphocera consobrina*, Saussure, Spic. Ent., ii, p. 62, n. 23 (1887).

*Hab.* Transvaal (*Saussure*).
Not in Mr. Distant's collection.

Genus Hoplolopha.

*Hoplolopha*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 36 (1876); Saussure, Spic. Ent., ii, p. 63 (1887).

92. *Hoplolopha lineata.*

*Pamphagus lineatus*, Stål, Rec. Orth., i, p. 24, n. 5 (1873).
*Xiphocera lineata*, Saussure, Spic. Ent., ii, p. 65, n. 24, pl. iii, fig. 16, 17 (1887).
*Akicera grisea*, ♂ (nec. ♀), Serville, Ins. Orth., p. 606 (1839).

*Hab.* Transvaal: Pretoria (?) (*Distant*).

93. *Hoplolopha reflexa.*

*Pamphagus reflexus*, Walker, Cat. Derm. Salt., iii, p. 535, n. 5 (1870).
*Xiphocera camelina*, Saussure, Spic. Ent., ii, p. 67, n. 26, pl. iii, fig. 18, 19 (1887).

*Hab.* Cape; Transvaal (*Saussure*).

94. *Hoplolopha horrida.*

*Pamphagus horridus*, Burmeister, Handb. Ent., ii, p. 617 (1838).

*Hab.* Cape Colony: Grahamstown (*Schonland*, Feb. 25); Brak Kloof (*Mrs. G. White*, March 1895).

Several specimens, approximately agreeing with the insufficient description of this species. Antennæ 16-jointed, joints 3—11 flattened, broader than long, 12 and 13 narrower, almost square; terminal joint broadly fusiform, about twice as long as broad.

## CYRTACANTHACRIDÆ.

### *EUTHYMIINÆ.*

### Genus Lentula.

*Lentula*, Stal, Bihang Vet. Akad. Handl., v (4), pp. 45, 90 (1878).

95. *Lentula obtusifrons.*

*Lentula obtusifrons*, Stal, Bihang Vet. Akad. Handl., v (4), p. 90 (1878).

*Hab.* Barberton (*Rendall*); Natal: Zululand (B. M.).

One immature specimen from Barberton of this interesting and little-known species.

### *OXYINÆ.*

### Genus Oxya.

*Oxya*, Serville, Ann. Sci. Nat., xxii, p. 282 (1831); Ins. Orth., p. 675 (1839); Stål, Rec. Orth., i, pp. 41, 81 (1873).

96. *Oxya viridivitta.*

♂ *Heteracris viridivitta*, Walker, Cat. Derm. Salt., iv, p. 660, n. 10 (1870) (South Africa).

♀ *Heteracris humeralis*, Walker, l. c., p. 662, n. 16 (1870) (Madagascar).

*Hab.* Transvaal: Pretoria, one ♀ (*Distant*): South Africa (*Sir A. Smith*); Madagascar (*Ida Pfeiffer*); Lagos (*Strachan*).

I refer the few specimens I have seen to the same species with some hesitation; but the material before me is too small for absolute certainty. In the two females the costal area is dilated near the base as much as in the Australian genus *Bermius*, Stål.

*GONYACATHINÆ.*

Genus GONYACANTHA.

*Gonyacantha*, Stål, Rec. Orth., i, p. 43, note (1873).

97. *Gonyacantha ensator.*

*Mesops ensator*, Walker, Cat. Derm. Salt., iii, p. 501, n. 5 (1870).

*Hab.* MOZAMBIQUE: Mopea (Coll. *Distant*); NATAL (*Gueinzius*).

*MESOPINÆ.*

Genus MESOPS.

*Mesops*, Serville, Ann. Sci. Nat., xxii, p. 267 (1831); Ins. Orth., p. 585 (1839); Stål, Rec. Orth., i, p. 44 (1873).

98. *Mesops laticornis.*

*Mesops laticornis*, Krause, Sitz. Akad. Wiss. Wien, 76 (1), p. 49, pl. ii, fig. 13 (1877).

*Hab.* TRANSVAAL: Waterberg, Warm Baths (*Distant*); SENEGAL: SIERRA LEONE (*Krause*); NATAL; BRITISH EAST AFRICA: Samburu (collected by *C. S. Betton*, Nov. 1896), Zomba (B. M.).

*MESAMBRIINÆ.*

Genus ANTHERMUS.

*Anthermus*, Stål, Bihang Vet. Akad. Handl., v (4), pp. 24, 68 (1878).

99. *Anthermus granosus.*

*Anthermus granosus*, Stål, Bihang Sv. Handl., v (4), p. 68 (1878).

*Hab.* TRANSVAAL: Pretoria (*Distant*); NATAL (Brunner's collection).

Four specimens were obtained by Mr. Distant.

*CYRTACANTHACRINÆ.*

Genus CYRTACANTHACRIS.

*Cyrtacanthacris*, Walker, Cat. Derm. Salt., B. M., iii, p. 550 (1870).

*Acridium vel Acrydium*, Serville, Ann. Sci. Nat., xvii, p. 282 (1831); Ins. Orth., p. 141 (1839); *et auct. seq.*; *nec Acrydium*, Geoffroy.

I retain this name provisionally for an extensive group of large migratory locusts, much in need of sub-division, which are generally designated by the inapplicable name *Acridium*. Walker makes two genera, *Cyrtacanthacris* and *Acridium*; but all the African species included in the present paper are enumerated by him under *Cyrtacanthacris*.

100. *Cyrtacanthacris tatarica.*

*Gryllus* (*Locusta*) *tatarica*, Linnæus, Syst. Nat. (ed. x), i, p. 432, n. 46 (1788); Mus. Ludov. Ulric. p. 139 (1764).

*Acridium ruficorne*, Burmeister, Handb. Ent., ii, p. 630, n. 9 (1838); Stål, Rec. Orth., p. 60, n. 2 (1873); *nec* Fabricius.

‖ *Acridium succinctum*, Serville, Ins. Orth., p. 642 (1839), *nec* Linnæus.

*Hab.* TRANSVAAL: Pretoria (*Distant*); Johannesburg; Barberton (*Rendall*); NATAL (A. R.).

The true *C. ruficorne*, Fabricius, is a West African insect.

101. *Cyrtacanthacris rubella.*

*Acridium rubellum*, Serville, Ins. Orth., p. 645 (1839); Stål, Rec. Orth., i, p. 62 (1873).

*Hab.* TRANSVAAL: Pretoria, Zoutpansberg (*Distant*); Barberton (*Rendall*); Delagoa Bay (*Distant*).

102. *Cyrtacanthacris variegata.*

*Cyrtacanthacris variegata*, Walker, Cat. Derm. Salt., iii, p. 557, n. 18 (1870).

*Cyrtacanthacris internum*, Walker, l. c., iv, p. 613 (1870).

‖ *Acridium ruficorne*, Serv. (*nec* Fabr.), Ins. Orth., p. 643 (1839).

*Acridium hottentottum*, Stål, Rec. Orth., i, p. 62 (1873).

*Hab.* TRANSVAAL: Barberton; NYASALAND, Fort Johnston (*Rendall*).

This species varies in the number of spines on the hind tibiæ. The normal number on the outer carina is six, but some specimens in the British Museum have as many as nine.

### 103. *Cyrtacanthacris fascifera.*

*Cyrtacanthacris fascifera*, Walker, Cat. Derm. Salt., B. M., iii, p. 558, n. 20 (1870).

*Hab.* NYASALAND: Fort Johnston (*Rendall*); CONGO (*type*); ZULULAND; MOZAMBIQUE; NATAL; MOMBASA; MAURITIUS (B. M.).

### 104. *Cyrtacanthacris septemfasciata.*

*Acridium septemfasciatum*, Serville, Ins. Orth., p. 661 (1839).

*Cyrtacanthacris purpurifera*, Walker, Cat. Derm. Salt., iii, p. 561, n. 25 (1870).

*Hab.* TRANSVAAL: Pretoria (swarm, Nov. 1894) (*Distant*); NATAL: Durban (*Distant*), Pine Town (A. R.).

### 106. *Cyrtacanthacris subsellata.*

*Cyrtacanthacris subsellata*, Walker, Cat. Derm. Salt., iii, p. 559, n. 21 (1870).

*Hab.* NATAL: Pine Town (Coll. *Distant*).

Perhaps a form of *C. septemfasciata*, Serv.

### 107. *Cyrtacanthacris distanti*, sp. n.

♂ *Cyrtacanthacris prasina*, Walker, var. β, Walk., Cat. Derm. Salt., iv, p. 563 (1870).

♀ *Cyrtacanthacris auricornis*, var. (?), Walker, l. c. (1870).

*Hab.* TRANSVAAL: Pretoria (*Distant*); NATAL (*Gueinzius*).

Long. corp. 33–56 millim.; exp. al. 66–86 millim.

Light green, sides of pronotum narrowly edged before and behind with pink. These borders are connected below the median carina by a more or less distinct pink or brownish stripe on each side, and the front border is sometimes edged behind by a blackish line,

sometimes slightly expanded above, and sometimes indistinctly visible as a mere shading along the lower lateral border of the pronotum. Hinder pink border of the pronotum throwing up a short oblique branch at its lower extremity, not extending beyond the hinder sulcus. Hind lobe of the pronotum more coarsely punctured than the rest; prosternal tubercle moderately stout, long, conical, pointed, recurved, and touching the front of the pronotum in the female; in the male it is somewhat shorter, and less curved. Tegmina subhyaline-greenish, with greenish or whitish nervures, the longitudinal nervures, and the densely reticulated upper basal third of the anal area, inclining to reddish. Wings greenish-hyaline, with pale yellow longitudinal nervures; legs green; hind femora with a dark red line on the basal half of the outer carina; terminal lobe of the femora green, surrounded with black both within and without, except below; tibiæ green, black at the intersection with the femora, and generally with a pink ring half-way between the knee and the first spines, which are pale yellow, tipped with red, and which number six to eight on the outer carina, and eight on the inner carina. Tarsi sometimes red.

This insect may be a pale form of *C. prasina*, Walk., from which *C. auricornis* is scarcely distinct, but *C. prasina* has much heavier blackish markings on the pronotum, scarcely marked with red; the tegmina, except along the anal border, are thickly and uniformly reticulated with reddish, and the hind tibiæ and tarsi are entirely red, except the extreme base of the tibiæ, which is green, like the femora.

It is also probably allied to *C. deckeni*, Gerstaecker, which appears to be quite distinct from any species I have yet seen.

### *MONACHIDIINÆ.*

### Genus ABISARES.

*Abisares*, Stål, Bihang Vet. Akad. Handl., v (4), p. 29 (1878).

### 108. *Abisares viridipennis.*

*Monachidium viridipenne*, Burmeister, Handb. Ent., ii, p. 626, n. 5 (1839).

*Hab.* NYASALAND: Zomba, Fort Johnston (*Rendall*): NATAL (A. R.).

A very common species in East Central Africa.

*CATANTOPINÆ.*

Genus EUPROPACRIS.

*Eupropacris*, Walker, Cat. Derm. Salt., B. M., iii, p. 642 (1870).

109. *Eupropacris genuale.*

*Acridium genuale*, Walker, Cat. Derm. Salt., iv, p. 625 (1870).

This species was founded on a specimen from East Africa, of which almost every marking has been obliterated by spirit, except on the inside of the legs. Still, I cannot venture to regard the better-coloured specimens before me as new, so I append a fresh description.

Long. corp. 30–35 millim. ; 60–62 millim.

*Female.* Head yellow. Antennæ, a streak on the frontal ridge below the antennæ, the greater part of the spaces on each side between the inner and outer pairs of carinæ, several spots on the mouth-parts, and two short stripes behind the eyes, nearly connected by a streak beyond, all black. Vertex and pronotum with a broad blackish or reddish stripe, darkest in front, expanding from between the eyes to the extremity of the pronotum ; this is bordered on each side with yellow, separating it from a broad darker or paler reddish band, bordered beneath with yellow, which runs obliquely across the pronotum and pleura, which are thickly rugose-punctate. Abdomen reddish or yellowish, with black sutures. Four front legs reddish, middle femora striped with yellow beneath. Hind femora yellow, the outer middle area with two blackish or reddish stripes, meeting at the extremity ; inner surface blackish or reddish, nearly to the knees, which are also blackish, or reddish, and sometimes preceded by a pale band. Hind tibiæ yellow above, and blackish below, or uniform reddish, as well as the tarsi. Tegmina dull red, with whitish reticulations ; costal area darker. Hind wings red, with red nervures, and subhyaline, especially towards the extremity.

*Hab.* NYASALAND : Zomba (*Rendall*) ; FWAMBO ; TANGANYIKA (B. M.).

Allied to the South African *E. spectabilis*, Walker ; and as regards the pattern of the head and pronotum, to *E. dominans*, Walk., from Silhet and Singapore.

Genus CATANTOPS.

*Catantops*, Schaum, Mon. Berl. Akad., 1853, p. 779; Peters' Reise Mossamb. Zool., v, p. 134 (1862).

### 110. *Catantops capicola.*

*Acridium (Catantops) capicola*, Stål, Eugenie's Resa, Orth., p. 331 (1860).

*Catantops humeralis*, Stal (an Thunberg?), Rec. Orth., i, p. 69, n. 1 (1873); Œfv. Vet. Akad. Förh., xxxiii (3), p. 40 (1876).

*Hab.* Transvaal: Pretoria (*Distant*); Nyasaland (*Rendall*).

A somewhat variable species; the descriptions are very unsatisfactory, and I cannot identify any specimens with *humeralis*, Thunberg, or *distinguendum*, Stal. In two specimens, the dark band on the sides of the pronotum is continued to its hinder edge; but they do not otherwise differ from the rest of the specimens.

In another variety, the upper dark band on the femora is partially obliterated in front and within.

### 111. *Catantops vittata*, sp. n.

Long. corp. 19 millim.

Fawn-colour, with a black band slightly bordered with whitish running backwards from the eye in a straight line over the sides of the pronotum, and continued over the costal area of the tegmina. The upper half of the central area of the outside of the hind femora with a broad black stripe; inside apparently red, with two black spots; hind tibiæ mostly red, with black spines. Antennæ concolorous; frontal carinæ nearly obsolete.

*Hab.* Transvaal: Pretoria (*Distant*); Delagoa Bay (*Distant*).

### 112. *Catantops decorata.*

*Catantops decoratus*, Gerstaecker, Von der Decken, Reisen in Ost-Afrika, iii (2), p. 44, pl. iii, fig. 4 (1873); Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 40 (1876).

*Hab.* Transvaal: Pretoria (*Distant*); British Central Africa: Zomba (*Rendall*); Nyasaland: Fort Johnston (*Rendall*).

### 113. *Catantops melanosticta.*

*Catantops melanostictus*, Schaum, Mon. Berl. Acad., 1853, p. 779; Peters' Reise Mossamb., v, p. 134, pl. VIIa, f. 5 (1862).

*Hab.* Transvaal: Pretoria (*Distant*), Delagoa Bay (*Distant*); Nyasaland: Fort Johnston, Zomba (*Rendall*); Sierra Leone; Congo (B. M.).

One of the commonest African species, and the type of the genus.

### 114. *Catantops urania*, sp. n.

Long. corp. 44 millim.; exp. al. 77 millim.

*Female.* Brown; vertex, pronotum and pleura rugose-punctate; vertex, cheeks and pronotum with scattered black dots, especially towards the median line of the pronotum, where they are more or less continuous, and expand outwards in two diverging lines from before the hinder suture. Abdomen with a row of shining black spots on the back, decreasing nearly to the extremity. Hind femora yellowish, with the carinæ and angles of the central area dotted with black; central area dull greenish, except on the sides and middle; upper surface with two transverse black bands extending to the inner surface, the first about the middle, and the second half-way between this and the black knees; under-surface black externally and red internally. Lower projecting lobes yellow. Tibiæ and tarsi vinous red, with two yellow spots towards the base, followed by a broader yellow band above; nine white, black-tipped spines in the outer row, and ten in the inner. Post-sternal lobes subcontiguous. Tegmina brownish, subhyaline towards the tips, and more or less reticulated and mottled with darker brown transverse nervules. Hind wings pale blue, hyaline, with black nervures.

*Hab.* Transvaal: Pretoria, Barberton (*Distant*); Nyasaland: Fort Johnston, Zomba (*Rendall*).

Allied to *C. spissa*, Walk., from West Africa; but *C. spissa* is smaller, the wings are much less distinctly blue, and the pattern of the hind femora is different. *C. urania*, however, so much resembles the description of *Acridium arthriticum*, Serville, in almost every particular (size included), that I should have identified it with that species without hesitation, but that Serville's description of the hind legs of his *A. arthriticum* seems to agree with those of a *Calliptamus*. Can he have had a specimen of the present species with the legs of some large *Calliptamus* substituted for its own?

The description of *C. urania* is taken from the specimen from Zomba.

Genus Stenocrobylus.

*Stenocrobylus*, Gerstaecker, Arch. f. Nat., xxxv, p. 219 (1869); Von der Decken's Reisen, iii (2), p. 45 (1873).

115. *Stenocrobylus* (?) *trifasciatus*, sp. n.

Long. corp. ♂ 18 millim., ♀ 22 millim.; long. al. ant. ♂ 9 millim., ♀ 14 millim.

Rufo-testaceous; antennæ black, except the basal joint in the male; the incisions very narrowly ringed with pale. A broad black stripe, bisected by the pale dorsal carina, runs from the back of the pronotum to the extremity of the scutellum of the vertex, where it ends in a point; there is also a black stripe on each shoulder, narrowed in front, extending behind the eye to the extremity of the pronotum; between this and the central band are some blackish dots at the back; and the sides of the pronotum and pleura are marked with scattered black dots. Tegmina with a short black stripe (sometimes obsolete) beyond the base of the costa, and a median black stripe, scarcely reaching the base, extending for about ½ the length; above this is a row of partly-connected and variable black spots, and two or more black spots on the basal half of the anal area. Prosternal tubercle broad at the base, obtusely rounded at the extremity, and more slender in the male than in the female. Hind femora with three partly macular black bands, converging behind, on the outer central area; and the outer spaces above and below dotted with black; the upper and median spaces on the inner surface are also largely black, and the lower space dotted with black. Hind tibiæ with a black line above, and with eight black-tipped spines on the outer carina. Wings considerably shorter than the abdomen in both sexes.

*Hab.* Transvaal: Barberton (*Rendall*).

Described from two males and four females.

There are several species allied to this in the British Museum, but with wings as long or longer than the abdomen. I refer them, with some slight hesitation, to Gerstaecker's genus *Stenocrobylus*.

The species nearest to *S. trifasciatus* is very abundant at Zomba, and I add a description below.

116. *Stenocrobylus* (?) *whytei*, sp. n.

Long. corp. 16–25 millim.

Testaceous, hardly shading into rufous. Antennæ black, except at the extreme base, vertex and pronotum with a double central stripe,

as in the last species, and with a narrow, sharply-defined, black shoulder-stripe running from the eye to the end of the pronotum. Sides of the pronotum with several large black spots round the edges, but otherwise, like the pleura, almost destitute of black dots, though coarsely punctured. Tegmina rather longer than the abdomen, with a black line on the costa towards the base, and a broad central black band, intersected by the pale longitudinal forking nervures. Wings hyaline. Legs thickly dotted with black, hind femora with a row of rather large black spots in the middle of the outer central area. Tibiæ blackish below, and with eight black-tipped spines on the outer carina. Prosternal tubercle conical, rounded at the tip, rather more slender than in the last species.

Found abundantly by Mr. A. Whyte at an elevation of 2000–3000 feet at Zomba in September (Brit. Mus.).

### *CALLIPTAMINÆ.*

### Genus Euryphymus.

*Euryphymus*, Stal, Rec. Orth., i, p. 72 (1873); Œfv. Vet. Akad. Förh., xxxiii (3), p. 40 (1876).

### 117. *Euryphymus erythropus.*

*Gryllus erythropus*, Thunberg, Mém. Acad. Pétersb., v, p. 248 (1815), ix, p. 426 (1824).
*Calliptamus* (*Euryphymus*) *erythropus*, Stal, Rec. Orth., i, p. 73 (1873).

*Hab.* Transvaal: Pretoria, Masil. Nek (*Distant*).

About twenty specimens. The black pattern on the back of the pronotum varies a little in form, sometimes extending to the back of the pronotum; but it more frequently ceases before reaching the extremity.

### Genus Calliptamus.

*Calliptamus*, Serville, Ann. Sci. Nat. xxii, p. 284 (1831); Ins. Orth. p. 686 (1839); Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 43 (1876).
*Caloptenus*, Burmeister, Handb. Ent., ii, p. 637 (1839).

### 118. *Calliptamus antennatus*, sp. n.

Long. corp. 16 millim.

*Male.* Testaceous. Antennæ black beneath, frontal ridge mottled,

distinctly marked with blackish, and a black band, widening hindward, extending backwards from between the eyes, over the occiput and pronotum, but having a moderately broad pale border on each side. Sides of head with a black stripe running down from the eye, and another further back, with a whitish stripe between them; sides of pronotum with two whitish and three blackish stripes, the lowest of the latter triangularly expanded; beneath it the colour is testaceous, as is also the hinder lobe of the pronotum, which is more strongly punctured than the rest. Pleura testaceous, mottled with black. Hind femora testaceous; on the outer side are three short blackish longitudinal marks on the middle of the central lobe; the spaces between the lower carinæ are black on the outside, and red on the inside, inner surface of the hind femora black to the middle, after which follows a pale space, and another longitudinal black one, ceasing before the hinder lobe, which is concolorous, being only marked with a blackish stripe on the inside at its base. Hind tibiæ coral red, with nine yellow black-tipped spines on each carina. Tegmina longer than the abdomen, yellowish subhyaline, with large reticulated blackish spaces on the median line, separated by pale spaces; anal area pale. Wings probably hyaline, tinged with red at the base.

*Hab.* Transvaal: Pretoria (*Distant*).
Allied to *C. hottentottus*, Stål.

### 119. *Calliptamus tibialis*, sp. n.

Long. corp. 32 millim.; exp. al. 63 millim.

*Female.* Head testaceous; the middle of the frontal ridge, a line on the outside of its lateral borders, and two lines below the eyes, more or less blackish; cheeks sometimes with a whitish bloom, which extends to the hinder suture on the sides of the pronotum. Pronotum narrowed in front, a slight depression on the vertex between the eyes at the narrowest part; the dark band on the frontal ridge broadens behind it over the pronotum; the sides, lateral lobes, and terminal carina (which is obtusely produced and rounded off in the middle above) testaceous; two slightly oblique black stripes on the sides of the pronotum from the front to the hinder suture, the uppermost broadest. Tegmina brown, varied with yellowish and whitish subhyaline spots and transverse stripes; towards the tips largely subhyaline; a testaceous stripe (seen in closed specimens to be the continuation of the pale sides of the pronotum) occupies the upper and outer part of the anal area of the tegmina; wings hyaline. Hind femora above yellowish, with two or three blackish bands, and also with blackish mottlings and black dots on the carinæ, but all more or less indistinct. Inner and lower

side red ; outer median area glaucous-white, the upper and sometimes the lower bounding carinæ spotted with black ; central area glaucous-white, the angulated lines yellowish, with about six ill-defined blackish dots on each. Hind tibiæ and tarsi red ; tibiæ rather hairy, with about seven black-tipped spines on each carina.

*Hab.* Transvaal : Pretoria ; Waterberg, Warm Baths (*Distant*) ; Pemba Island (*Burtt*).

A very distinct species. Described from seven specimens from Pretoria, one from Pemba Island, and one from Waterberg ; the last is rather darker-coloured than the others. There are also four specimens from Zomba in Mr. Distant's and the British Museum Collection, which differ in their generally darker colour ; the upper black stripe on the sides of the pronotum extends more or less distinctly to the front, and sometimes backwards to the hinder extremity of the pronotum ; the black markings on the upper surface of the hind femora are more clearly defined, and the middle area on the outer side is sometimes suffused with black ; and the pleura and abdomen are more or less varied with black. In one specimen the hind tibiæ are vinaceous, with traces of one or two yellowish bands towards the base, not extending to the upper surface. But *Orthoptera* are so liable to change colour more or less after death that I do not consider these differences of sufficient importance to indicate even a well-marked local form.

In one specimen from Pretoria the pronotum is dark brown above on the sides, as far as the lateral carinæ, and reddish along the central carina ; and in the Pemba Island specimen, the pronotum is reddish-testaceous above, and though the front part is blackish, the black is not symmetrical, and appears to be due to accidental discoloration.

## Genus Caloptenopsis.

*Caloptenopsis*, Bolivar, Jorn. Sci. Lisb. (2), i, p. 173 (1889).

### 120. *Caloptenopsis fratercula*, sp. n.

Long. corp. ♂ 18 millim. ; ♀ 23 millim.

Testaceous ; sides of head, pronotum, and outer and lower part of hind femora more or less glaucous-white. Head mostly testaceous ; central ridge sulcated above between the eyes ; the lower part with traces of a double black central line, and border-lines ; one black line

below the eye ; sides of head indistinctly mottled with black, pronotum with an expanding brown band above, sometimes intersected by the pale central carina, and broadly bordered with paler ; sides of pronotum mottled with black, and with one or two short, slightly oblique white stripes, alternating with black ones, on the lower part of the sides in front ; hinder edge with distinct black dots. Hind border of pronotum above almost rectangular. Tegmina pale testaceous subhyaline, central area with a row of black spots separated by subhyaline transverse stripes, and increasing in size to the middle, and then diminishing ; on the outer third is a double instead of a single one. Costal and anal area with a few black spots ; anal area black below at the base. Wings hyaline, with a slight bluish tinge. Sides of abdomen with a double row of brown dots; hind femora on the middle outer area glaucous-white, with black spots on the angular striæ ; or with alternate tawny and bluish-white striæ, the former spotted with black. Upper surface of hind femora testaceous, with three black bands ; inner surface black, with a testaceous space between this and the knee, which is usually heavily and extensively marked with black, and throws off a short black line below the lower central carina. Hind tibiæ testaceous, with seven black-tipped spines.

*Hab.* Transvaal: Pretoria (*Distant*); Delagoa Bay (*Distant*).

Described from eight specimens.

Resembles *Calliptamus hottentottus*, Stål, superficially, but that species has the wings tinged with red instead of blue. In one specimen, the dark mark usually filling up the centre of the pronotum is absent, though the corresponding mark on the back of the vertex is present.

### 121. *Caloptenopsis uniformis*, sp. n.

Long. corp. 19-23 millim.

Head with the narrowest space between the eyes, and the frontal curve above the antennæ, with a long excavation between two parallel carinæ ; the frontal ridge between and below the antennæ entire, punctured. Rufo-testaceous ; face, sides of head, pronotum, pleura, and legs more or less varied with glaucous-white. Pronotum above smooth, without black markings, rarely longer than broad, except that it is rectangularly produced behind ; sides subparallel, very slightly approximating in front, the lateral and terminal carinæ slightly marked with yellow, upper part of sides of pronotum blackish below the yellow carinæ. Tegmina reddish, with some

indistinct transverse subhyaline markings; costal and apical third hyaline; anal area probably green in life. Wings hyaline. Hind femora glaucous on the outer side, the carinæ and transverse curves rufous; upper carinæ serrated. Inner surface black, with a yellowish space before and around the deep black crescent on the terminal lobe; a black line extends from it for a short distance on the outer side below the lower median carina. Tibiæ and tarsi yellowish (reddish during life ?) with black-tipped spines, six or seven on the outer, and seven on the inner carina. Prosternal tubercle transverse, not narrowed at the extremity. Terminal spines on the inside of the hind tibiæ long, hairy, the second considerably longer than the first.

*Hab.* TRANSVAAL: Pretoria (*Distant*).

Described from three males and one female.

Closely allied to *C. fratercula*, but apparently distinct.

### *EUPREPOCNEMINÆ.*

### Genus HETERACRIS.

*Heteracris*, Walker, Cat. Derm. Salt., iv, p. 655 (1870).

‖ *Demodocus*, Stål (*nec* Guérin, 1842), Bihang Vet. Akad. Handl., v (4), p. 75 (1878).

Walker's genus *Heteracris* is very heterogeneous; but as Stål's name *Demodocus* is preoccupied, it will be convenient to retain Walker's name in this restricted sense, rather than to impose a new one, as twelve out of Walker's forty-three species appear to belong to it. *Acridium herbaceum*, Serville, may conveniently be regarded as the type.

### 122. *Heteracris cognata.*

*Heteracris cognata*, Walker, Cat. Derm. Salt., B. M., iv, p. 658, n. 6 (1870).

*Hab.* TRANSVAAL: Barberton; NYASALAND: Fort Johnston (*Rendall*); NATAL (*Gueinzius*; B. M. types).

The disc of the hind femora is infuscated on both sides in the specimen from Barberton, but this is not the case in the types, with which it otherwise agrees very well. Walker's types are rather larger than Mr. Rendall's specimens, and the colour of the hind tibiæ is indeterminate (probably faded); in the latter they are blue, with a broad pale band near the base.

123. *Heteracris bettoni.*

*Heteracris bettoni*, Kirby, Proc. Zool. Soc. Lond. (1902), (*ined.*).

*Hab.* Transvaal: Pretoria (*Distant*), Delagoa Bay (*Distant* and *Muir*); Nyasaland: Fort Johnston (*Rendall*).

A species widely distributed in East and Central Africa, easily recognized by the usual dark band ceasing in the middle of the hinder lobe of the pronotum, instead of extending to the extremity.

Genus Euprepocnemis.

*Euprepocnemis*, Fieber, Lotos., iii, p. 178 (1853).
*Eupropocnemis*, Stål, Rec. Orth., i, p. 75 (1873).

124. *Euprepocnemis pulchripes.*

*Caloptenus pulchripes*, Schaum, Monatsber. Akad. Berl., 1853, p. 779; Peters' Reise nach Mossamb. Zool., v, p. 138, pl. VIIa. fig. 7 (1862).

*Hab.* Transvaal: Barberton (*Distant*); Nyasaland: Fort Johnston (*Rendall*); Mozambique (*Schaum*).

A single male specimen from Barberton of a species which seems to be somewhat rare. The antennæ are thickened in the middle, with long moniliform joints. Schaum describes and figures a female. There is also a single faded specimen from Fort Johnston.

125. *Euprocnemis ornatipes.*

*Cyrtacanthacris ornatipes*, Walker, Cat. Derm. Salt., iv, p. 575, n. 50 (1870).

*Hab.* Nyasaland: Fort Johnston (*Rendall*).

Walker's type is a female without locality, but I believe I am correct in referring the single male specimen obtained by Mr. Rendall to the same species.

## VI. *An Entomological Excursion to Central Spain.* By George Charles Champion, F.Z.S.

[Read March 5th, 1902.]

In the Transactions of the Entomological Society for 1897, pp. 427–434, Mrs. M. de la Bêche Nicholl has given us an interesting account of her travels in Aragon and Castile, accompanied by a list of the butterflies she met with, and a description of the general features of the places visited. Dr. Chapman and I having journeyed through the same district during the past summer, it is proposed here to supplement Mrs. Nicholl's paper by giving some particulars concerning the Coleoptera and Hemiptera noticed by us, Dr. Chapman having already published various notes on the Lepidoptera. The date of our visit, July 6th to August 10th, though probably the best time for the majority of the Lepidoptera, was, of course, much too late for most of the beetles, the characteristic Longicorn genus *Dorcadion*, and many of the Carabidæ, Malacodermata, Elateridæ, etc., being nearly or quite over, owing to the vegetation on the lower ground being already dried up. Still this was amply compensated for by the discovery of a conspicuous *Buprestis*, not previously recorded from Spain, the abundance of various Lepturids, etc. So far, too, as at present ascertained, the most interesting captures in the Coleoptera, as well as in the Hemiptera-Heteroptera, were made in the lower, hot, arid regions, where the fauna resembles that of Algeria, and not in the pine-forested and more humid mountainous districts, which have a beetle-fauna very similar to that of the Eastern Pyrenees. Some of the species met with in these pine-forests, we had captured at Arcachon, in the Landes, on our way out, as *Melanotus tenebrosus, Spondylis buprestoides, Monohammus gallo-provincialis, Hylotrupes bajulus, Magdalis memnonia, Buprestis octomaculata, Chrysobothrys solieri*, etc. It was a pleasant surprise to me, having previously travelled to the Sierra Nevada and other places in Southern Spain, to find such extensive forests of pine as still clothe the mountains which form the watershed of the rivers Tagus, Jucar and

Guadalaviar, in contrast to the arid, almost treeless regions passed over on our outward and homeward journeys through the country.

Arriving at Madrid on July 6th, where we had the good fortune to meet Señores Bolivar and Uhagon, we devoted the two following days to a visit to the Escorial (where we also met another entomologist, José Hernandez Alvarez, of the Escuela de Montes) and Toledo respectively. Leaving again on the 9th for Cuenca, about nine hours distant by rail, we remained there till the 18th, working daily up the Huecar gorge or valley, or on to the arid hills in the vicinity of the town. This valley was still green enough to afford very good collecting-ground, as, apart from the river, there were springs in various places issuing through the precipitous rocks from the adjacent high ground. The new road in course of construction, however, had to be avoided, it being deep in dust, from the constant passage of the mules dragging down the timber from the distant pine-forests. About six miles up the valley was the village of Palomera, near which we found several productive spots on the banks of the stream, and a few miles above that again, leaving the Huecar for a time, and ascending through scattered pines, a limestone cave on the hill-side was visited, though no beetles were obtained therein. The most noticeable insects seen about Cuenca, exclusive of the numerous butterflies, were a day-flying *Rhizotrogus* (*pygialis*, Muls.); several species of *Zonabris*, in abundance, *Leptura* (*unipunctata*, F.), *Clytanthus*, *Trichodes*, *Anthaxia*, etc., on very spiny plants; various Cetoniidæ, *Lixus*, *Larinus*, etc., on thistles; a *Cerocoma* (*mühlfeldi*, Gyll.), *Omophlus ruficollis*, F., two species of *Lebia*, etc., on flowers; a curious Anthribid (*Trigonorhinus arcolatus*, Boh.), on shrubs in the evening, etc. Here, too, in the Huecar valley, there were plenty of Pentatomidæ and other Hemiptera, an extremely variable *Eurydema* swarming on certain plants, the most dissimilarly-coloured forms being often seen in copulâ; and two species of *Crioceris* were noticed on the asparagus plants. On the hills, which are clothed in places with many spiny plants, as evidence of a much more abundant fauna to be met with earlier in the season, we found a large *Thylacites* (*chalcogrammus*, Boh.) in some numbers, a beautiful *Chlænius* (*martinezi*, Ganglb.), *Purpuricenus hidensis*, Goeze, various *Tentyria*,

*Heliopathes*, *Aristus*, *Acinopus*, *Steropus*, *Ophonus*, etc. About "stercore humano," only too abundant everywhere on the outskirts of Cuenca, the very local *Akis sansi*, Sol., and a large *Blaps*, were not uncommon. The Jucar river, which is joined by the Huecar in the middle of the city, and down which large numbers of logs are floated, did not look very attractive for collecting, the valley being much barer of vegetation (and we therefore paid but little attention to it) above the town, though we followed the stream down for some distance. Here, *Plagiodera* swarmed on a species of *Salix* and a *Haltica* on poplar, both stripping the trees of their leaves, the destructive *Galerucella lutcola*, Müll., on elm, two species of *Notoxus*, etc. On the sandy banks of the streams about Palomera, *Omophron*, *Acylophorus*, *Pæderus*, *Tachyusa*, *Potaminus*, etc., occurred, and in the water itself various interesting species of *Deroncetes*, *Gyrinus*, *Elmis*, *Ochthebius*, and *Parnus*. At Cuenca we were again fortunate enough to meet a young entomologist, Juan Jiménez Cano, and he accompanied us on various excursions. Leaving this place in company with this gentleman, on July 17th, for the first stage of our journey across the mountains of Castile into Aragon, for which a guide and horses were with difficulty procured, we reached Uña, in the vicinity of the lake of that name, the same afternoon passing on our way the curious place known as the "Ciudad Encantada" (Enchanted City), and very interesting from a geological point of view, passing the night in very primitive quarters. Here, in the village, as elsewhere, the widely-distributed and conspicuous Longicorn *Spondylis buprestoides*, L., was noticed quite commonly on the wing towards evening. The district hereabouts, as noted by Mrs. Nicholl, looked very good for entomological work, the slopes of the adjacent hills being clothed with pine-forest, and there being plenty of flowers in the marshy ground round the lake, but as we had decided to go on as soon as possible to Tragacete, we made an early start next morning for that place. This day's journey, which lay through a very hilly, almost uninhabited country, clothed in great part with open pine-forest, was a very fatiguing one, to two of our party at least, one of our guides losing his way for some hours, the right track being regained with difficulty, ten hours in all being spent in the saddle. At Tragacete, where we obtained accommodation in the house of Indalechio Martinez, we remained till July 26th. This

village, which lies in the upper part of the valley of the River Jucar, at an elevation of about 4000 feet, proved to be an excellent centre for work, there being plenty of pine-forest and other suitable ground in the vicinity. Many excursions were made up the Jucar, which descends through a long narrow gorge before reaching Tragacete, sometimes to near its source, amongst the extensive pine-forests, and we never failed to bring back some interesting insects. In the open places, as at Cuenca, there was the usual abundance of *Zonabris*, *Zonitis*, *Cerocoma*, *Trichodes* (four species), *Leptura unipunctata*, *Clytanthus ruficornis*, etc., on *Eryngium* and other spiny flowering plants. Higher up, in the wooded ground, on the Umbelliferæ, etc., various Longicornia were to be found, as *Leptura stragulata*, Germ., and *Strangalia pubescens*, F., both in plenty, and both varying in colour to entirely black, *L. distigma*, Charp. (a beautiful insect alive), *L. sanguinolenta*, L., *Pachyta* 4-*maculata*, L., and divers species of *Lebia*, *Acmæodera*, *Anthaxia*, *Corælus*, *Haplocnemus*, *Malachius*, *Mycterus*, *Mordella*, *Chrysanthia*, *Œdemera*, etc. On the pine-trees, on which we had the pleasure of first finding the handsome larva of *Grællsia isabellæ*, various beetles were met with, as *Brachyderes suturalis*, Graells, *Scythropus*, *Pissodes*, a pallid *Cryptocephalus* (near *C. pini*, L., but with a smooth thorax), a similarly-coloured *Galerucid*, *Magdalis*, etc. On the pine-timber, or under its bark, we obtained three species of *Buprestis*, *Anthaxia*, *Temnochila*, *Plegaderus*, *Platysoma*, *Paromalus*, *Tachyta nana*, Gyll., *Placusa*, *Menephilus*, *Hypophlœus*, *Hylastes*, *Tomicus*, *Crypturgus*, *Monohammus*, *Criocephalus*, *Spondylis*, and others. In dung in the road *Aphodius carpetanus*, Graells (in plenty), *Bubas*, *Copris*, *Emus*, etc., occurred. The wet moss on the stones in the river (here reduced to a narrow stream) harboured *Bembidium ibericum*, Pioch., and an *Ocalea* (in plenty), as well as *Orectochilus* and an *Aneyrophorus*; on the stones themselves, here or elsewhere near Tragacete, were several *Elmis*, *Ochthebius*, *Hydræna*, and *Parnus*; and on the banks, various *Tachyusa*, *Scopæus*, *Pæderus*, *Bembidium*, *Blemus*, *Cryptohypnus*, and *Hydrocyphon*. The old deserted nests of the pine processionary-moth *Thaumatopœa pityocampa*, Schiff., hanging on the upper branches of the pines, when one had pluck enough to handle them, furnished *Dermestes aurichalceus*, Küst., in abundance. In grassy places on the hill-sides, *Melöe majalis*, L., was frequently

to be seen, travelling much more rapidly than most of its congeners, and very snake-like in its movements; here, too, we found *Carabus rugosus*, F., and *C. melancholicus*, F., *Chlænius martinezi*, Ganglb., *Steropus insidiator*, Pioch., various *Harpali* (*zabroides*, Dej., etc.), *Acinopus*, *Aristus*, *Cyrtonus*, *Timarcha*, *Asida*, *Heliopathes*, *Dorcadion*, etc. Leaving Tragacete on July 26th, we worked our way on foot to Guadalaviar, a village close under one of the highest points in the district, the Muela de San Juan, crossing on our way the upper valley of the Tagus and the Portillo de Guadalaviar, the high ridge known under the latter name forming the boundary between Castile and Aragon. All these mountains are clothed with pines to the summit, and none of them are high enough (under 7000 feet) for really alpine forms; nevertheless near the top of this ridge, on the northern side, in some open places amongst the trees, a good many interesting beetles were found under the larger stones which had been cleared away from the cultivated patches of ground, as *Cathormiocerus* (two species, one perhaps undescribed), and various *Hyperæ*, *Cymindis*, *Zabrus*, *Carabus*, and *Harpalus*. Sleeping one night at Guadalaviar, we again moved on early the next day *en route* for Albarracin, on foot as before, the greater part of the way lying over undulating arid districts till we descended abruptly to the fertile valley of the River Guadalaviar, at the village of Trama Castilla. Hence on to Albarracin, about nine miles distant, our route was along a fine, new road, wholly uninteresting from an entomological point of view, the last two miles or so through a very narrow, deep, winding gorge, at the mouth of which the town is situated, perched upon an eminence formed by an abrupt angle of the river, and completely barring the outlet. This new road, extending from near Teruel to the mining districts above Noguera, is carried straight under Albarracin by a tunnel, near the entrance to which we obtained lodgings at a house by the road-side, the "Posada Nueva," the proprietor of which, José Narro, knew something of entomology, having collected at times for Father Bernardo Zapater, who lived close by, and Herr Max. Korb of Munich, the Father himself, in spite of his great age, helping us in many ways. At Albarracin we remained till August 8th, making one long excursion, however, to Bronchales, in the Sierra, about fifteen miles distant, and sleeping there two nights. The most pro-

ductive localities in the vicinity of Albarracin were:—(1) The gorge of the Guadalaviar, about five miles down the Teruel road, and the adjacent savin-covered foothills of the Sierra: (2) the pine-forests on the ridges of the Puerto de Losilla, about the same distance off. On these lower hills we were fortunate enough to discover the fine Buprestid, *B. sanguinea*, F.,* and a new Capsid, belonging to the genus *Nasocoris*, Reuter, both on *Ephedra nebrodensis*, an *Equisetum*-like plant of the order Gnetaceæ. Here, too, we noticed various *Zonabris*, *Zonitis*, *Clytanthus*, *Coptocephala*, *Lachnæa*, *Clythra*, *Cryptocephalus*, and *Trichodes* (*8-punctatus*, F.), most of these resting on the spiniest plants; and, under stones, the large, crepitating *Aptinus displosor*, Duf., and divers *Ophonus*, *Steropus*, *Acinopus*, and many scorpions were to be seen. On the summit of the pine-ridge, at Puerto de Losilla, *Rhynchites cæruleocephalus*, Schall., and *Hispa testacea*, L., abounded on *Cistus* (the *Hispa* having been noticed by us in a similar way at Arcachon, a fortnight or so earlier), and on the pines there were the usual *Scythropus*, *Magdalis*, *Pissodes*, *Spondylis*, and *Buprestis* (*8-guttata*, L.). Under large stones, at the same place, many small Coleoptera and Hemiptera were obtained, as *Rhytirrhinus variabilis*, Bris., *Thylacites guinardi*, Duv., *Galeatus maculatus*, H.-S. (in the greatest profusion), *Acalypta*, *Agramma*, and a new *Piezostethus* allied to *P. cursitans*, Fall. Lower down, under stones, adjacent to the cultivated ground, we found various *Chrysomela*, *Timarcha*, *Cyrtonus*, and *Harpalus*, *Adimonia tanaceti* in abundance (as in most of the other places visited), etc.; and on ragwort and other flowers *Lebia crux-minor*, L., a *Malachius* or two, various Pentatomids, *Phymata*, etc. The streams hereabouts produced divers *Parnus*, *Potaminus*, *Elmis*, *Hydræna*, *Pæderus*, *Tachys*, and *Bembidium*. On this ridge of the Puerto de Losilla we also met with *Erebia zapateri*, Oberth., in some numbers, and all in very fresh condition, on the last day of our stay at Albarracin. August 3rd—5th were spent at Bronchales, whence we travelled in a springless country-cart up the new road to as far as Noguera, the remaining five miles or so of the journey across the mountain-ridge being accomplished on foot. Here, as at Tragacete and Losilla, there was an abundance of pine-forest, and in the opener places the Umbelliferæ were in full flower, producing *Chrysanthia*

* Cf. *Trans. Ent. Soc. Lond.*, 1901, pp. 379–384, t. 13.

*viridissima*, *Leptura stragulata*, and *Strangalia pubescens*, in more or less abundance, as well as *Acmæodera*, and other species already noticed at Tragacete. On the pines, again, there were the usual *Buprestis*, *Brachyderes*, *Magdalis*, and *Criocephalus*, and also *Prionus coriarius*, L., and *Elater præustus*, F. By beating young trees in a marshy place we obtained *Lebia crux-minor*, *L. cyathigera*, and *L. cyanocephala*. Here, too, we had the pleasure of taking *Erebia zapateri* in numbers, the larva of *Graellsia isabellæ*, etc.

Leaving Albarracin, finally, on August 8th, our journey home was much accelerated by the new line of railway opened a few weeks before, from Teruel to Calatayud, one of the stations, Cella, being only about four hours distant, a long diligence journey, or a detour by the Mediterranean coast, being thus avoided. Of our wearisome railway journey from Calatayud, by way of Zaragoza, Pamplona, San Sebastian, etc., to the frontier at Hendaye, it is not necessary to speak, except to note the abrupt change from the arid districts of the interior to a very green and fertile region as the northern coast was approached.

The Teruel district, as noted by Mrs. Nicholl, has been much worked by Father Zapater, who has resided for many years at Albarracin, and Herr Korb, but as they are chiefly devoted to Lepidoptera, it is probable they have not paid very much attention to the beetles. So far as I am aware, no collected account of the Coleoptera of Cuenca or Albarracin has hitherto been published, and the following preliminary list of species met with by us may be of interest, though, as compared with what might be found a month earlier, it is no doubt very incomplete. The Hemiptera-Heteroptera are, of course, still less known, and a list of them is also appended.

The following species were captured, amongst others not yet identified * :—

[Tr. = Tragacete; Alb. = Albarracin; Guad. = Guadalaviar; Br. = Bronchales.]

### Coleoptera.

*Cicindela flexuosa*, F., on the banks of streams, Cuenca; *C. campestris*, L., dark var., Br. *Carabus melancholicus*, F., and *C. rugosus*, F., under stones, Tr.; *C. latus*, Dej., Sierra

* I am indebted to MM. Bedel, Reitter, Schilsky, and Tschitscherine for assistance in naming some of the Coleoptera, and to Dr. O. M. Reuter and Mr. E. Saunders for their help with the Hemiptera.

Alta, Br., Tr., Guad., under stones, rare. *Omophron limbatus*, F., Cuenca (also seen at Toledo), on the sandy banks of streams. *Bembidium ibericum*, Pioch., in plenty in moss on stones in stream, and *B. punctulatum*, Drap., *B. stomoides*, Dej., ? etc., on its sandy banks, Tr. *Tachys parvulus*, Dej., on banks of stream, Alb. *Tachyta nana*, Gyll., under bark of pines, Tr. *Perileptus areolatus*, Creutz., on banks of stream, Tr. *Platynus viridicuprens*, Goeze, under stones, Alb.; *P. scrpunctatus*, L., and *P. parumpunctatus*, F., marshy places, Tr., Br. *Synuchus nivalis*, Panz., and *Platyderus montanellus*, Graells, under stones, Tr. *Steropus insidiator*, Pioch., under stones, Tr., Alb., Guad., Uña; *S. sp.* ?, Guad. *Percus sp.* ?, Alb. *Pœcilus crenulatus*, Dej., Guad. *Orthomus hispanus*, Dej., Guad., Tr. *Amara equestris*, Duft., var. *zabroides*, Dej., Tr., Guad., Br., Uña; *A. acuminata*, Payk., Guad. *Zabrus spp.* ?, undetermined, Guad. *Acinopus picipes*, Oliv., under stones, not rare, Cuenca, Guad., Tr., Alb. *Aristus capito*, Dej., and *A. clypeatus*, Rossi, under stones, Cuenca, Tr. *Ophonus sabulicola*, Panz., Guad.; *O. diffinis*, Dej., Alb.; *O. azureus*, F., Alb., Tr., Guad.; *O. cordatus*, Duft., Guad., Alb., Tr.; *O. rotundatus*, Dej., Cuenca. *Harpalus zabroides*, Dej., under stones and clods of earth, not rare, Tr. *Stenolophus teutonus*, Schr., Alb. *Anisodactylus binotatus*, F., Br., Tr. *Chlænius martinezi*, Ganglb., under stones, etc., on the dry hill-sides, not rare, Cuenca, Tr., Guad.; *C. nigricornis*, F., Guad. *Lebia crux-minor*, L., var. *nigripes*, Dej., on flowers and by beating young trees, Alb., Tr., Br., Cuenca; *L. cyathigera*, Rossi, Br.; *L. turcica*, F., Cuenca; *L. rufipes*, Dej., Cuenca; *L. cyanocephala*, L., Tr., Cuenca, Br. *Cymindis miliaris*, F., and *C. spp.*, under stones, Portillo de Guadalaviar, Tr., Alb., Br. *Aptinus displosor*, Duf., under stones on dry hill-sides, Alb. *Brachinus crepitans*, L., Br., Tr., Guad.

*Deronectes hicostatus*, Schaum, not rare, in small running stream, above Palomera, near Cuenca; *D. opatrinus*, Germ., with the preceding, and at Tragacete. *Hydroporus halensis*, F., *H. lepidus*, Oliv., with the preceding, Cuenca. *Agabus didymus*, Oliv., *A. chalconotus*, Panz., *A. guttatus*, Payk., *A. bipustulatus*, L., Tr. *Dytiscus marginalis*, L., Cuenca. *Haliplus badius*, Aubé, Cuenca. *Gyrinus urinator*, Ill., *G. natator*, Ahr., Cuenca. *Aulonogyrus striatus*, Aubé, Cuenca. *Orectochilus villosus*, F., Tr.

*Hydræna* (2 sp.) and *Ochthebius* (3 sp.), Tr., Cuenca.

*Potaminus substriatus*, Müll., Alb., Cuenca. *Parnus*

*nitidulus*, Heer, Cuenca; and two other species, Alb., Tr., Cuenca.

*Ocalea sp.* ?, in moss on stones in stream, in plenty, Tr. *Tachyusa balteata*, Er., *T. coarctata*, Er., and *Ischnopoda umbratica*, Er., on banks of streams, Cuenca, Tr. *Falagria thoracica*, Curt., Tr. *Placusa sp.* ?, under pine-bark, Tr. *Pronomæa rostrata*, Er., Tr. *Emus hirtus*, L., in dung, Tr. *Staphylinus stercorarius*, Oliv., Guad. *Ocypus cyaneus*, Payk., Guad., *O. cupreus*, Rossi, Tr. *Acylophorus glabricollis*, Lac., not rare on the sandy banks of streams, Palomera, Cuenca. *Pæderus gemellus*, Kr. ?, abundant on the banks of streams, Tr., Cuenca. *Scopæus spp.* ?, Alb., Tr., Cuenca. *Stenus guttula*, Müll., Cuenca, Tr.; *S. bipunctatus*, Er., Cuenca; *S. ater*, Mann., Alb.; *S. filum*, Er., Tr. *Bledius sp.* ?, Tr. *Ancyrophorus aureus*, Fauv., Tr.

*Temnochila cærulea*, Oliv., on fallen pines, or under bark of these trees, rare, Tr. *Dermestes aurichalceus*, Küst., abundant in the old nests of *Thaumatopœa pityocampa*, Schiff., on the branches of pines, Alb., Tr. *Attagenus piceus*, Oliv., on flowers, Uña, Cuenca, Alb.; *A. trifasciatus*, F., on flowers, Cuenca. *Orphilus niger*, Rossi, Tr. *Platysoma oblongum*, F., *Paromalus flavicornis*, Herbst, *Plegaderus sanatus*, Truqui, under pine-bark, Tr. *Hister sinuatus*, F., in dung, Tr. *Subcoccinella* 24-*punctata*, L., Cuenca. *Exochomus auritus*, Scriba, Br. *Coccinella* 14-*pustulata*, L., commonly by beating low plants, Tr., Br., Alb.; *C. doublieri*, Muls., Cuenca. *Mysia oblongoguttata*, L., on pines, Tr. *Hyperaspis reppensis*, Herbst, Tr.

*Gymnopleurus flagellatus*, F., on the roads, Tr., Alb. *Bubas bubalus*, Oliv., *Copris lunaris*, L., *Onthophagus schreberi*, L., in dung, Tr. *Aphodius carpetanus*, Graells, in profusion on one occasion in dung in the road (but overlooked at the time for the common *A. rufipes*, L.), Tr. *Ammœcius spp.*, Lago de Uña, Tr. *Trox sp.*, Alb. *Geotrupes lævigatus*, F., common, Alb. *Rhizotrogus pygialis*, Muls., not uncommon, flying in the hot sun, and variable in colour, Cuenca, Tr., Br.; *R. pini*, Oliv., Br.; *R. solstitialis*, L., var. *pineticola*, Graells, Br.; *R. rufescens*, Latr., Tr., Guad.; *R. tornosi*, Perez, Br. *Anoxia villosa*, F., Cuenca. *Chasmatopterus villosulus*, Ill., Alb. *Hoplia farinosa*, L., Cuenca, Alb. *H. philanthus*, Füssl., Tr. *Anisoplia bætica*, Er., not uncommon, and very variable in colour, Cuenca, Tr. *Cetonia oblonga*, Gory, common on thistles, Cuenca; *C. aurata*, L., *Oxythyrea stictica*, L., Cuenca.

*Buprestis flavomaculata*, F., common on felled pines, in the hot sunshine, Tr., Br., Losilla; *B. rustica*, L., and *B. octoguttata*, L., on pines, Tr., Losilla; *B. sanguinea*, F., not uncommon on *Ephedra nebrodensis*, between Albarracin and Cea. *Poecilonota sp.* ?, a single specimen of a large species allied to *P. rutilans*, F., picked up dead on the road in the town of Cuenca. *Anthaxia cræsus*, Vill., Tr.; *A. hypomelæna*, Ill., Cuenca; *A. confusa*, Lap., Tr.; *A. quadripunctata*, L., in pine-woods, on flowers and on logs, common, Tr.; *A. cichorii*, Oliv. ?, on flowers, Cuenca, Tr., Br. *Acmæodera tæniata*, F., and *A. bipunctata*, Oliv., on flowers of Umbelliferæ, Br., Tr. *Chrysobothrys solieri*, Lap., on cut pine-timber, Br. *Corœbus spp.*, Tr., Cuenca. *Agrilus sp.* ?, Tr. *Throscus spp.*, Cuenca. *Elater præustus*, F., Guad., Br. *Cryptohypnus dermestoides*, Herbst, Tr. *Melanotus tenebrosus*, Er., Cuenca. *Cardiophorus rufipes*, Goeze, Cuenca. *Corymbites latus*, F., Tr. *Hydrocyphon australis*, Lind. ?, Cuenca. *Rhagonycha melanura*, Oliv., swarming on flowers, Uña, Tr. *Malthodes*, *Malachius*, *Attalus*, *Ebæus*, *Henicopus*, *Dolichosoma*, *Dasytes*, *Haplocnemus*, *Psilothrix*, various spp., not yet determined. *Thanasimus formicarius*, L., Guad., Losilla. *Trichodes apiarius*, L., Tr., Alb., Guad.; *T. octopunctatus*, F., Tr., Br., Uña; *T. ammios*, F., common, Cuenca, Tr., Guad.; *T. leucopsideus*, Oliv., Guad., Br., Tr., Alb., common, and extremely variable in size, all four species on flowers, particularly of *Eryngium*. *Lasioderma lævc*, Ill., Cuenca.

*Tentyria spp.*, Cuenca, Guad. *Stenosis sp.*, Alb. *Akis sansi*, Sol., common, Cuenca, about "stercore humano"; *A. sp.*? Alb. *Blaps gigas*, L., Cuenca. *Asida spp.*, not determined, Tr., Cuenca, Alb., Guad. *Colpotus similaris*, Muls., Alb. *Heliopathes montivagus*, Muls., common under stones in dry places, Cuenca, Guad., Tr., Br.; *H. spp.*? Alb., Guad. *Microzoum tibiale*, F., under stones, Puerto de Losilla. *Pentaphyllus chrysomeloides*, Rossi, Uña. *Corticeus pini*, Panz., under pine-bark, Tr. *Helops sp.*, Tr. *Monophilus cylindricus*, Herbst, under pine-bark, Tr. *Eryx ater*, F., Uña. *Omophlus ruficollis*, F., common, Cuenca, etc. *Lagria lata*, F., Alb., Br.; *L. hirta*, L., Cuenca, etc. *Scraptia dubia*, Oliv., common, by beating herbage, Cuenca. *Formicomus pedestris*, Rossi, Cuenca. *Notoxus trifasciatus*, Rossi, and *N. monoceros*, L., common on bushes by the Jucar, Cuenca. *Anthicus rodriguezi*, Latr., Tr.; *A. aubei*, Laf., Cuenca; *A. tristis*, Schmidt, Alb.; *A. instabilis*, Schmidt, Alb. *Mordella aculeata*, L.,

Br., Tr.; *M. fasciata*, F., Tr. *Mordellistena* and *Anaspis spp.*, undetermined, Cuenca, etc. *Pentaria defarguesi*, Abeille (= *oberthuri*, Champ.), and *P. badia*, Rosenh., Cuenca. *Silaria trifasciata*, Chevr., Cuenca, Alb.; *S. brunnipes.*, Muls., Br., Tr.; *S. varians*, Muls., Tr. *Emenadia præusta*, Gebl., Tr.; *E. bimaculata*, F., Cuenca. *Meloe majalis*, L., not rare on hill-sides, Tr., Guad. *Zonabris quadripunctata*, L., *Z. variabilis*, Oliv., and various species, undetermined, some of them very abundant at Cuenca, Tragacete, etc. *Cerocoma mühlfeldi*, Gyll., locally abundant on flowers, Cuenca, Tr. *Zonitis præusta*, F., common on flowers of *Eryngium*, Guad., Tr., Cuenca, Alb.; *Z. mutica*, Scriba, Cuenca; *Z. sp.*? (near *Z. quadripunctata*, F., var. *korbi*, Esch.), Cuenca. *Œdemera flavipes*, F., Tr.; *Œ. simplex*, L., Cuenca; *Œ. sp.*? Tr. *Chrysanthia viridissima*, L., common on umbelliferous flowers, in pine-forests, Br., Tr. *Mycterus curculionoides*, F., on flowers, with the preceding, Br., Tr., Alb.

*Otiorrhynchus sp.*? one specimen, under a stone, Portillo de Guadalaviar (the only representative of the genus met with). *Scythropus squamosus*, Kies., on pines, Tr. *Brachyderes suturalis*, Graells, abundant on pines, Tr., Guad., Losilla, Br.; *B. sp.*, Tr. *Cathormiocerus lapidicola*, Chevr.?, and *C. sp. n.*? under stones, Portillo de Guadalaviar. *Thylacites chalcogrammus*, Boh., under stones in dry places, not rare, Cuenca; *T. guinardi*, Duv., under stones, Losilla. *Cleonus ophthalmicus*, Rossi, Cuenca, Tr. *Lixus turbatus*, Gyll., Tr.; *L. cribricollis*, Boh., Cuenca. *Bubalocephalus rotundicollis*, Cap., a few specimens under stones, on high ground, Puerto de Losilla, Portillo de Guadalaviar, Tr. *Hypera hispanica*, Cap., and *H. sp.*? under stones, with the preceding, Guad., Tr. *Rhytirrhinus variabilis*, Br., under stones, Losilla, Guad. *Pissodes pini*, L., Br.; *P. notatus*, F., Tr., Losilla, Br. *Ceuthorrhynchus echii*, F., Cuenca, Tr.; *C. ferrugatus*, Perris, Losilla. *Baris nitens*, F., Cuenca. *Brachytemnus porcatus*, Germ., Tr. *Balaninus ochreatus*, Fähr., Tr. *Rhamphus flavicornis*, Clairv., Cuenca. *Magdalis memnonia*, Gyll. *M. frontalis*, Gyll., on pines, more or less common, Tr., Br., Losilla. *Cionus longicollis*, Bris., on *Verbascum thapsus*, Tr. *Apion wenckeri*, Bris., on *Cistus*, Losilla; *A. cyanescens*, Gyll., Br.; *A. atomarium*, Kirby, Tr. *Auletobius pubescens*, Kies., on *Cistus*, Br. *Rhynchites cæruleocephalus*, Schall., in profusion on *Cistus*, Puerto de Losilla; *R. auratus*, Scop., Tr. *Trigonorhinus* (*Brachytarsus*)

*areolatus*, Boh. (= *pardalis*, Woll.), common, by beating herbage towards evening, females predominating, Cuenca. These specimens agree precisely with Wollaston's type of *T. pardalis*, which, to judge from his remarks (Col. Hesp., p. 139), was almost certainly obtained in Algeria, and not in St. Vincent, Cape Verdes, as stated. Boheman's insect was from Sicily, and his description appears to have been made from a rubbed individual. *T. areolatus* also occurs in Italy, but it has not, perhaps, been previously recorded from Spain. The structure of the head is so different from that of *Brachytarsus*, that Wollaston's generic name will have to be retained for this species. *Hylastes palliatus*, Gyll., *Crypturgus sp.*, *Tomicus sexdentatus*, Boern., *T. laricis*, F., under bark of pines, Tr., *Pityogenes bidentatus*, Herbst, Uña.

*Spermophagus cardui*, Boh., common on flowers, Cuenca, Uña. *Spondylis buprestoides*, L., about pine-timber, and on wing towards evening, common, Tr., Cuenca, Uña, Alb. *Prionus coriarius*, L., Br. *Pachyta quadrimaculata*, L., Tr. *Leptura rubra*, L., sparingly, Br., Tr.; *L. unipunctata*, F., common, on *Eryngium* and other flowers, in open places, Tr., Cuenca, Guad.; *L. distigma*, Charp., on flowers of Umbelliferæ, in pine-forests, rare, Tr., Br.; *L. stragulata*, Germ. (including var. *nigrina*, Schauf.), plentiful, with the preceding, and extremely variable in colour, Br., Tr., and also at Guad.; *L. sanguinolenta*, L., Tr., Br., etc.; *L. livida*, F., Tr. *Strangalia pubescens*, F. (including var. *holosericea*, Muls.), plentiful, in company with *L. stragulata*, and also varying to entirely black, Br., Tr.; *S. maculata*, Poda, Br.; *S. bifasciata*, Müll., Cuenca. *Hylotrupes bajulus*, L., Tr., Cuenca. *Criocephalus rusticus*, L., on pine-stumps, Tr., Br. *Aromia moschata*, L., var. *thoracica*, Fisch., on willow, Tr. *Purpuricenus budensis*, Goeze, on Umbelliferæ, etc., Uña, Cuenca. *Clytanthus verbasci*, L., rare, Alb.; *C. ruficornis*, Oliv., common, on flowers of *Eryngium*, etc., Tr., Alb., Cuenca. *Dorcadion sp.*, not yet identified, three worn specimens, Tr., Muela de San Juan, Guad. *Monohammus gallo-provincialis*, Oliv., on pines, Tr. *Agapanthia sp.*, Tr., Cuenca. *Phytœcia affinis*, Harrer, Br. *Oberea erythrocephala*, Schrank, Tr., Cuenca.

*Donacia consimilis*, Schrank, Tr.; *D. linearis*, Hoppe, Cuenca; *D. sp.* (near *impressa*, Payk.), Cuenca. *Lema puncticollis*, Curt., Alb.; *L. melanopa*, L., Cuenca, Alb., Uña. *Crioceris* 12-*punctata*, L., and *C. asparagi*, L., com-

mon, on asparagus-plants in the cultivated ground by the Huecar, Cuenca; *C. merdigera*, L., Cuenca. *Tituboea biguttata*, Oliv., Cuenca. *Lachnæa sexpunctata*, Scop., and *L. vicina*, Lac., Alb. *Clythra læviuscula*, Ratz., Alb. *Coptocephala scopolina*, L., Alb., Br., Guad., Cuenca. *Cryptocephalus sexmaculatus*, Oliv., Alb., Tr.; *C. bimaculatus*, F., Alb., Cuenca; *C. imperialis*, Laich., Guad.; *C. violaceus*, Laich., Tr.; *C. pini*, L., on the pines, Br.; *C. sp.?*, very near the preceding, but with a smooth thorax, also on the pines, not rare, Tr., Guad., Losilla; *C. moræi*, L., Tr.; *C. crassus*, Oliv., Cuenca; *C. pygmæus*, F., Tr., Cuenca; and various other species of the genus, not yet determined, mostly found on low plants in open places. *Pachybrachys spp.*, Tr. *Stylosomus sp.*, Alb. *Timarcha hispanica*, H.-S. ?, in abundance, under stones on the edges of cultivated fields, Tr., Alb., Guad.; and other species as yet unidentified. *Cyrtonus cupreovirens*, Perez ?, in plenty, and *C. denticulatus*, Chevr. ?, rarely, under stones, Guad., Tr., Alb. *Chrysomela americana*, L., Cuenca; *C. grossa*, F., Tr.; *C. bætica*, Suffr., Alb., Cuenca; *C. analis*, L., Guad., Tr.; *C. hæmoptera*, L., Tr., Guad., Losilla; *C. menthastri*, Suffr., Tr., Cuenca, Uña. *Plagiodera versicolora*, Laich., abundant on willow, Cuenca. *Phytodecta ægrota*, F., Cuenca. *Galerucella luteola*, Müll., only too common on elms, Cuenca, Alb.; also seen at San Sebastian, on the north coast, on our way home. *Adimonia tanaceti*, L., in abundance, under stones near cultivated ground, Tr., Br., Guad., Alb. *Malacosoma lusitanicum*, L., Tr. *Sermyla halensis*, L., Br., Tr., Alb. *Luperus sp.?*, a pallid form occurring in company with a similarly-coloured *Cryptocephalus*, on the pines, Tr. *Monolepta erythrocephala*, Oliv., Tr. *Haltica sp.*, in profusion on young poplars, by the Jucar, Cuenca. *Aphthona lævigata*, F., Cuenca. *Cassida equestris*, F., Br. *Hispa testacea*, L., in abundance on *Cistus*, Losilla; *H. atra*, L., Cuenca.

## Hemiptera—Heteroptera.*

*Odontoscelis fuliginosa*, L., Tr.; *O. dorsalis*, F., Alb. *Odontotarsus grammicus*, L., Cuenca. *Eurygaster nigrocucullata*, Goeze, Alb.; *E. maroccana*, F., Cuenca. *Ancyrosoma albolineatum*, F., Cuenca. *Graphosoma lineatum*, L., Cuenca. *Brachypelta aterrima*, Forst., Cuenca. *Schirus morio*, L., Tr.; *S. dubius*, Scop., Guad., Alb., Cuenca, Tr.

* The synonymy adopted is that of Puton's Catalogue, 1899.

*Sciocoris sp.* (near *umbrinus*, Wolff), Cuenca. *Dyroderes umbraculatus*, F., Cuenca. *Ælia acuminata*, L., Tr. *Stagonomus italicus*, Gmel., Tr. *Staria lunata*, Hahn, Cuenca. *Carpocoris varius*, F., Cuenca, Alb. *Dolycoris baccarum*, L., Cuenca, Alb. *Peribalus splaceolatus*, F., Cuenca, Alb. *Rhaphigaster nebulosa*, Poda, Br. *Holcogaster fibulata*, Germ., on pines, Tr., Losilla. *Eurydema festivum*, L., abundant on low plants, and varying greatly in coloration, the most dissimilar forms often seen in copulâ, Cuenca; *E. oleraceum*, L., Tr. *Zicrona cærulea*, L., Cuenca. *Cyphostethus tristriatus*, F., Alb. *Phyllomorpha laciniata*, Vill., Alb., also seen at Toledo. *Centrocoris spiniger*, F., Alb., Cuenca. *Gonocerus juniperi*, H.-S., Cuenca. *Pseudophlœus falleni*, Schill., Cuenca. *Coreus hirticornis*, F., Alb., Cuenca. *Camptopus lateralis*, Ger., Cuenca, Tr. *Alydus calcaratus*, L., Tr. *Stenocephalus agilis*, Scop., Tr.; *S. albipes*, F., Cuenca. *Therapha hyoscyami*, L., Cuenca, Tr., Alb. *Corizus crassicornis*, L., Tr.; *C. parumpunctatus*, Schill., Br., Tr.; *C. subrufus*, Gmel., Tr. *Neides tipularius*, L., Cuenca. *Megalomerium meridionale*, Costa, Lago de Uña. *Berytus signoreti*, Fieb. ?, Alb. *Lygæus pandurus*, Scop., Cuenca; *L. equestris*, Tr.; *L. saxatilis*, Scop., Tr. *Cymus sp.*, Cuenca. *Geocoris grylloides*, L., Tr. *Platyplax salviæ*, Schill., Tr. *Microplax albofasciata*, Costa, Alb., Cuenca. *Macroplax fasciata*, H.-S., Alb. *Heterogaster urticæ*, F., Tr., Cuenca. *Stygnocoris fuligineus*, Fourc., Alb. *Aphanus quadratus*, F., Alb.; *A. saturnius*, Rossi, Tr.; *A. ibericus*, Baer. ?, Tr., Guad., Br. *Beosus maritimus*, Scop., Cuenca. *Emblethis sp.*, Tr., Guad., Alb. *Pyrrhocoris ægyptius*, L., Alb.; *P. apterus*, L., Cuenca. *Serenthia læta*, Fall., *Acalypta platychila*, Fieb., and *Galeatus maculatus*, H.-S., under large stones, on the summit of the pine-ridge, Puerto de Losilla, the last-mentioned in profusion. *Cataplatus carthusianus*, Goeze, Tr. *Monanthia echii*, Wolff, Cuenca. *Monosteira unicostata*, Muls. and Rey, Cuenca. *Phyllontocheila auriculata*, Costa, Cuenca. *Phymata crassipes*, F., Tr. *Hebrus pusillus*, Fall., Cuenca. *Velia currens*, F., Tr. *Gerris najas*, De G., Cuenca; *G. thoracicus*, Schum., Alb. *Reduvius personatus*, L., Tr. *Harpactor iracundus*, Poda, Cuenca; *H. erythropus*, L., Tr.; *H. sanguineus*, F., Tr. *Coranus subapterus*, De G., Guad., Tr. *Nabis ferus*, L., Lago de Uña. *Piezostethus, n. sp.*,* not

* This species and the new *Nasocoris* will be described by Dr. O. M. Reuter in the Entomologist's Monthly Magazine.

uncommon, under stones, with *Galeatus*, etc., Puerto de Losilla; *P. cursitans*, Fall., under pine-bark, Tragacete. *Miridius pallidus*, Horv., Tr. *Phytocoris spp.*, Br., Alb. *Adelphocoris seticornis*, F., Tr. *Brachycoleus triangularis*, Goeze, Cuenca. *Pachycyphus cæsareus*, Reut., not rare, on *Cistus*, Puerto de Losilla, Br. *Capsus scutellaris*, F., not rare, Tr., Cuenca, all the specimens having the scutellum rufous. *Liocoris tripustulatus*, F., Cuenca. *Pilophorus cinnamopterus*, Alb., Cuenca. *Lopus sulcatus*, Fieb., Alb., Cuenca. *Nasocoris, n. sp.*, on *Ephedra nebrodensis*; the two described species of this genus are from Algeria and Southern Russia respectively. *Strongylocoris niger*, H.-S., Alb. *Mimocoris coarctatus*, Muls. and Rey, Cuenca. *Neocoris nigritulus*, Zett., Cuenca. *Calocoris sulphureus*, Reut. ?, Cuenca. *Globiceps flavomaculatus*, F., Tr.

April 14, 1902.

## VII. *Notes on Hawaiian Wasps, with Descriptions of New Species.* By Robert Cyril Layton Perkins, B.A. Communicated by Dr. David Sharp, M.A., F.R.S.

[Read March 5th, 1902.]

The present paper deals only with the wasps which are found on the island of Hawaii, and the distinguishing characters of the many species are given in the table, which will enable the hymenopterist to readily separate the various forms. Only four or five of these species are found on any other island of the group, all the rest being peculiar to Hawaii. These species are more numerous and difficult than the Oahuan species, which I have previously tabulated (E. M. M., Vol. XII., 2nd Ser., p. 264), and consequently I have added sufficiently full descriptions of the new ones. Owing to the one sex (whether ♂ or ♀) frequently presenting striking characters not exhibited by the other, the table from 27 becomes double, the males being treated of from 27 to 59, the females from 60 to 92. Before 27 males and females are included under each head. In one or two cases I have included a species both under the ♂ and ♀, although the latter sex is not known to me, but in these cases the characters given are such as present no differences according to the sex. A little care is necessary in examining the emargination of the apex of the clypeus, as the depression behind it often makes it appear stronger than is really the case, and it should be noticed that strong cyanide is liable to turn the yellow markings red, especially the small frontal spot, the colour of which I have found it convenient to use in one case. I think it probable that the table includes nearly all the species that exist on Hawaii, and that very few more remain to be discovered.

### TABLE OF SPECIES.

1. (2) Postscutellum with an elevated ridge; second discoidal cell at the apex about twice as high as the third discoidal at its base. . . . . *O. nigripennis*, Holmgr.

2. (1) Postscutellum without a transverse elevated ridge; second discoidal cell at the apex generally much less than twice as high as the third at its base.
3. (14) Costæ of second ventral segment wanting, or much effaced and indistinct; *or* extremely short, the middle ones not so long as the transverse basal portion of the segment, which is before them.
4. (9) Second ventral segment greatly raised behind the transverse sulcature, very much higher than its basal portion.
5. (6) ♂. Mandibles and apex of clypeus red; propodeum smooth and shining with a few punctures in front; abdomen deep-black, shining. . . . . *O. cypris*, sp. nov.
6. (5) ♂. Mandibles and apex of clypeus not red; propodeum dull, *or* with the concavity densely and largely punctate.
7. (8) Posterior concavity of the propodeum coarsely and closely punctured; mesothorax shining between the punctures.
*O. eutretus*, sp. nov.
8. (7) Posterior concavity of propodeum dull, with at most some feeble and indefinite punctures; mesothorax not shining.
*O. heterochromus*, P.
9. (4) Second ventral segment little, or not at all, raised behind the costæ, or transverse sulcature.
10. (11) Front of head and mesothorax very dull, with the puncturation nearly effaced, hardly visible.
*O. egens*, P. (? var. = *O. infaustus*, P.).
11. (10) Mesothorax dull with distinct punctures, or shining and coarsely punctured.
12. (13) Mesothorax dull, finely punctured, abdomen often red-marked above or beneath. . . . . *O. cyanopteryx*, P.
13. (12) Mesothorax coarsely and closely punctured, shining between the punctures; abdomen entirely black.
*O. holomelas*, sp. nov.
14. (3) Costæ of second ventral segment always distinct, and never very short, the middle ones about as long or sometimes longer than the basal portion of the segment.
15. (26) First and second abdominal segments above red, or one or both spotted with red at the sides, the red colour sometimes dull and not obvious at a glance, the spots of second segment sometimes confined to the deflexed sides and hardly visible in dorsal view.
16. (17) First and second abdominal segments nearly wholly red, wings with only a slight blue iridescence.
*O. frater*, D. T.
17. (16) First and second segments only spotted with red; if

largely red then the wings have very conspicuous blue iridescence.

18. (19) ♂. Clypeus very deeply emarginate; sides of first and second segments obscurely red; mesothorax very dull, with very feeble or obsolete punctures; a median yellow spot behind the antennæ. . . . . *O. axestes*, P.

19. (18) ♂. Clypeus not very deeply emarginate; if deeply then the mesothorax is strongly and densely punctate.

20. (21) Depression of second ventral segment deep, very wide, impressed to the level of the costæ very widely at the base; front of head dull with fine, often nearly obsolete, punctures; second dorsal segment simple, when seen in profile not raised into a distinct hump at its basal third. *O. obscure-punctatus*, Blackb.

21. (20) Depression of second ventral segment not extremely wide, nor widely sunk at the base to the level of the apices of the costæ; front of head densely punctured or somewhat shining, *or* the second dorsal segment of abdomen is rather strongly raised to a point at its basal third.

22. (23) ♂. Apex of clypeus very distinctly dentately-emarginate; mandibles red; propodeum rugose. *O. dyserythrias*, P. var.

23. (22) ♂. Apex of clypeus sometimes depressed and dentate, but only slightly emarginate or truncate; mandibles red or dark; propodeum not rugose, sometimes a little roughened by some large, feebly-impressed punctures.

24. (25) Propodeum with some more or less evident, large shallow punctures; basal abdominal segment in strict lateral view very abrupt in front, so that its two faces meet at an angle (rounded off). . . . *O. rubopustulatus*, Blackb.

25. (24) Propodeum dull, but smooth, not punctured; lateral outline of basal abdominal segment forming an almost even but strong curve from the petiole. *O. crypterythrus*, sp. nov.

26. (15) Basal segments of abdomen not red above, nor spotted with red at the sides, at most with the apical margin of the basal segment narrowly red.

27. (60) *Males.* Antennæ 13-jointed, terminal ones modified to form a hook.

28. (29) Second ventral segment largely or entirely red. *O. dyserythrias*, P.

29. (28) Second ventral segment not red.

30. (39) Clypeus extremely deeply emarginate, the emargination almost semicircular or even deeper.

31. (32) Second segment beneath largely but lightly impressed behind the costæ; above, greatly raised into a conical tuberculate form. . . . . *O. dromedarius*, Blackb.

32. (31) Second segment beneath with a distinct wide depression, very deep at its base, *or else* it is hardly more than simply convex above, not raised into a conical or tuberculate form.

33. (34) Second segment beneath with the depression very deep at the base, above subtuberculately elevated; abdomen entirely black . . . . . *O. melanognathus*, P.

34. (33) Second segment beneath with a shallow or moderate depression; above simply convex, not tuberculately elevated; abdomen often yellow-banded or densely clothed with decumbent grey pubescence.

35. (36) Clypeus with one or two yellow spots (sometimes very small); depression of second ventral segment extremely shallow, sometimes hardly perceptible.

*O. newelli*, sp. nov.

36. (35) Clypeus without yellow spots; depression of second ventral segment distinct, moderate.

37. (38) Mesothorax and scutellum with appressed sericeous pubescence, so dense as to nearly conceal the surface, impunctate or very obscurely punctured.

*O. sociabilis*, P.

38. (37) Mesothorax less densely clothed and more strongly punctured, the scutellum with sparse and feeble, but evident, punctures. . . . . *O. scoriaceus*, P.

39. (30) Clypeus truncate or somewhat emarginate at apex, never very deeply so, often impressed at apex behind the emargination, which gives it an appearance of being deeper than is really the case.

40. (41) Abdomen with two yellow bands *and* the second ventral segment flat behind the costæ without a depression.

*O. cooki*, P.

41. (40) Abdomen sometimes with one, very rarely with two, yellow bands; if yellow-banded there is a distinct depression behind the costæ.

42. (43) Mesothorax very densely rugulosely punctured, the punctures not coarse nor deep, running into one another; (propodeum dull and smooth, at most a little rugose or with some obscure punctures; mandibles dark).

*O. venator*, P.

43. (42) Mesothorax not very densely rugulosely punctured (propodeum in some species conspicuously rugose and in some the mandibles are red).

44. (47). Second ventral segment with a large depression, deep in front, and extending back to or behind the middle of the part of the segment behind the costæ ; propodeum at the most slightly punctured or roughened, the posterior concavity dull but smooth, and without distinct sculpture ; mandibles red.
45. (46) Mesothorax extremely dull with the punctures extremely feeble or obsolete ; apex of clypeus not deeply impressed behind the emargination. . . . *O. erythrognathus*, P.
46. (45) Mesothorax not strongly but distinctly punctured ; apex of clypeus deeply impressed behind the emargination. *O. orbus*, P.
47. (44) Depression of second ventral segment sometimes wide and well-marked (but much less deep than that of the two preceding species), in which case the propodeum is rugose ; if the propodeum is smooth, the depression of second ventral segment is somewhat small and narrow, not reaching to the middle of the part of the segment behind the costæ ; in some species the depression is very shallow, and hardly or not perceptible ; mandibles dark in nearly all the species.
48. (49) A median spot behind the antennæ, and some thoracic markings as well as the hind margin of basal abdominal segment red. (Probably all except the median frontal spot sometimes wanting). . . . *O. mesospilus*, sp. nov.
49. (48) Head, thorax and abdomen not red-spotted. Sometimes a yellow or yellowish median frontal spot.
50. (55) Second dorsal segment more or less strongly raised from the base, not simply convex.
51. (52) Puncturation of mesothorax very fine and feeble, sometimes obliterated. . . . . *O. cyphotes*, P.
52. (51) Puncturation of mesothorax very distinct.
53. (54) Mesothorax very dull between the punctures. *O. vulcanus*, Blackb.
54. (53) Mesothorax more or less shining between the punctures. *O. hiloensis*, P., and *konanus*, P.
55. (50) Second dorsal segment simply convex.
56. (57) Second ventral segment with the depression shallow, but quite distinct ; (thorax extremely dull, appearing greyish from dense, very short, erect grey hairs ; puncturation very feeble or obsolete). . . . . *O. peles*, P.
57. (56) Second ventral segment with the depression excessively shallow, or obsolete ; mesothorax more or less distinctly punctured.

58. (59) Clypeus much produced, elongate ; no yellow spot behind the antennæ ; inter-antennal carina extremely sharp.
*Chelodynerus chelifer*, P.

59. (58) Clypeus wide, not much produced ; a yellow spot between the antennæ ; the inter-antennal carina less sharp.
*Pseudopterocheilus pterocheiloides*, P.

60. (27) *Females.* Antennæ 12-jointed, the apical joints simple.

61. (62) Maxillary palpi extremely long, regularly fringed with long hairs. . . *Pseudopterocheilus pterocheiloides*, P.

62. (61) Maxillary palpi normal.

63. (64) Mandibles extremely long and narrow, teeth obsolete or subobsolete, a distinct longish cheek between mandible and eye. . . . . *Chelodynerus* (gen. nov.) *chelifer*, P.

64. (63) Mandibles normal ; cheeks obsolete.

65. (84) Second dorsal segment of abdomen in profile distinctly raised from the base or very strongly convex, often tuberculate or subtuberculate in dorsal aspect ; if hardly tuberculate, but very strongly convex in profile, then *either* the mesothorax is shining between the punctures, *or* the depression of the second ventral segment is very wide and deep, and the segment prominent, and almost tuberculate on either side of the depression at its base.

66. (67) Mesothorax with extremely dense (shallow and not coarse) rugulose punctuation. . . . . *O. venator*, P.

67. (66) Mesothorax not so punctured.

68. (69) Second ventral segment with a very shallow large impression behind the costæ ; propodeum smooth.
*O. dromedarius*, Blackb.

69. (68) Second ventral segment with a large deep depression, *or* it is small, triangular, not extending half-way from the costæ to the apex (*O. cyphotes*), *or* the propodeum is rugose.

70. (71) A median *red* spot behind the antennæ (postscutellum and mesopleura sometimes also red-spotted, mesothorax deeply punctured, not dull, minute interstitial punctures very distinct, propodeum rugose). *O. mesospilus*, sp. nov.

71. (70) A yellow or yellowish spot behind the antennæ, or none.

72. (75) Mandibles red.

73. (74) Head normal ; mesothorax with the larger punctures very fine and feeble, sparse ; sometimes impunctate or nearly.
*O. erythrognathus*, P.

74. (73) Head incrassate ; mesothorax distinctly, but not coarsely, punctured. . . . . *O. orbus*, P.

75. (72) Mandibles dark, at most reddish at the apex.

76. (81) Mesothorax very dull.
77. (78) Mesothorax distinctly and rather strongly punctured; propodeum conspicuously rugose, even in the posterior concavity. . . . . *O. vulcanus*, Blackb.
78. (77) Mesothorax at the most finely and very feebly punctured; propodeum at most a little roughened, or with some very feebly impressed coarse punctures, making it subrugose.
79. (80) Second ventral segment with a small depression, only distinct for a short way behind the costæ. *O. cyphotes*, P.
80. (79) Second ventral segment with a large, wide, deep depression, extending more than half-way from the costæ to apex of the segment. . . . . *O. melanognathus*, P.
81. (76) Mesothorax more or less shining between the punctures, never dull.
82. (83) Depression of second ventral segment wide. *O. konanus*, P.
83. (82) Depression of second ventral segment not very wide. *O. hiloensis*, P.
84. (65) Second dorsal segment simple, only ordinarily convex in profile; mesothorax not shining; depression of second ventral segment only moderately deep at base or sometimes very shallow.
85. (86) Minute interstitial punctures of mesothorax under a very strong lens present, but very feeble and not dense, inconspicuous owing to the microscopic surface sculpture; apex of clypeus very slightly emarginate or truncate. *O. peles*, P.
86. (85) Minute interstitial punctures of mesothorax very dense; apex of clypeus often rather strongly emarginate.
87. (90) Depression of second ventral segment very feeble or entirely wanting, wings not very dark and with little or no blue iridescence.
88. (89) Depression of second ventral segment feeble but present. *O. newelli*, sp. nov.
89. (88) Depression of second ventral segment wanting, surface flat beyond costæ, the basal part of the segment consequently appearing tumid. . . . . *O. cooki*, P.
90. (87) Depression of second ventral segment quite distinct, wings dark with blue or steely iridescence.
91. (92) Front of head finely and very feebly punctured. *O. sociabilis*, P.
92. (91) Front of head densely and distinctly punctured. *O. scoriaceus*, P.

*Odynerus cypris*, sp. nov.

Niger, mandibulis clypeique apice rufis, abdominis segmento primo postice flavomarginato (an semper?). Frons capitis dense punctata, clypeo distincte emarginato. Mesonotum sparsim punctatum, interstitiis etiam distincte punctulatis. Propodeum læve, nitidum, parce punctatum. Abdominis segmentum secundum supra fere æqualiter convexum; subtus, post sulcum transversum fortiter abrupte elevatum, costis nullis, sulco nitido, depressione post sulcum angustissima. Alæ fuscæ, nitentes, violaceo-iridescentes. ♂. Long. ad. apicem abd. seg. 2di. 8 m.m.

*Hab.* Puna, Hawaii.

*Odynerus cutrctus*, sp. nov.

Niger, mandibulis ex majore parte vel totis nigris, fronte media post antennas sæpe rubronotata; alis infuscatis, cæruleo-iridescentibus. Frons capitis densissime punctata, apice clypei subimpresso, truncato aut vix emarginato. Mesonotum nitidum, fortiter dense punctatum, propodeo lævi, postice dense punctato. Abdominis segmentum 2 dorsale simpliciter convexum, haudquaquam elevatum; ventrale post sulcum transversum fortissime abrupte elevatum, sulco nitido. ♂ ♀. Long. 7–10 m.m.

Sp. *O. heterochromo*, affinis, thorace nitido, multo grossius punctato, et sulco transverso segmenti ventralis 2i nitido distinctissima.

*Hab.* Hawaii, in several districts.

*Odynerus holomelas*, sp. n.

Niger, mandibulis rufis, alis infuscatis cæruleo-iridescentibus. Frons capitis densissime punctata, clypei apice plus minusve impresso, levissime emarginato aut truncato. Mesonotum grossius dense punctatum, haud opacum, propodeo postice grosse punctato. Abdominis segmentum 2 ventrale post costas haudquaquam elevatum, costis ipsis brevissimis, depressione post costas nulla. ♂ ♀. Long. 6–10 m.m.

Sp. huic affinis est *O. cyanopteryx*, Perk., qui thorace peropaco, multo subtilius punctato, et abdomine sæpius aut supra aut infra rufonotato, conspicue differt.

*Hab.* Widely distributed on Hawaii, but not generally common.

*Odynerus crypterythrus*, sp. n.

Niger, mandibulis et nonnunquam apice clypei rufis ; abdominis segmenti primi et secundi lateribus vel secundo solo rufonotatis. Caput et pronotum opacum, illo minus dense subtilius irregulariter punctato, propodeo lævi, haud nitido, impunctato. Abdominis segmentum a basi distincte subtuberculatim elevatum ; subtus, depressione distincta, costis sat longis. Alæ infuscatæ, cæruleo-iridescentes. ♂ ♀. Long. 7–9 m.m.

Sp. *O. obscure-punctato*, et *O. rubropustulato*, similis et affinis, ab hoc differt mesonoto multo subtilius punctato et propodeo haudquaquam punctato ; ab illo depressione segmenti 2 ventralis minus lata, costarum apices ab basim multo minus late attingente.

*Hab.* Found on both sides of HAWAII, but probably much scarcer than the allied species.

*Obs.* This species further differs notably from the allied species, in the form of the basal abdominal segment. In these the front face or basal part is extremely abrupt, and in profile its outline forms an angle (rounded off) with the dorsal face. In the present species the lateral outline is a strong, but almost even curve from the petiole to the apex.

*Odynerus newelli*, sp. nov.

Niger, clypeo flavonotato, abdominis segmentis 2 basalibus postice flavomarginatis, alis haud aut vix evidenter cæruleo-iridescentibus. Clypeus profunde emarginatus, capitis fronte subtiliter, remotius et plus minusve obsoletim punctata. Mesonotum opacum distincte sat dense nec grosse punctatum, propodeo rugoso vel subrugoso. Abdominis segmentum 2 dorsale haudquaquam elevatum ; ventrale post costas depressione levissima, nonnunquam vix discernenda, signatum. ♂. Long. 7–10.

Sp. *O. smithii*, D.T., cognatissima, capitis fronte subtilius, obsoletius et remotius punctata distinguenda.

*Hab.* Hilo, HAWAII, on the coast and also on the Kona coast.

The ♀ will no doubt differ by its black clypeus, less deeply emarginate, and the less distinct abdominal bands, probably one or both being generally wanting. This species was discovered by Bro. Matthias Newell.

*Odynerus mesospilus*, sp. nov.

Niger, fronte inter antennas rufonotata. Pronotum ♂ et abdominis segmentum basale, mesopleura utriusque sexus, et postscutellum ♀, nonnunquam rufonotata, sed variabilia. Clypeus levissime emarginatus vel truncatus, capitis fronte densissime subrugosa punctata. Mesonotum fortiter punctatum, interstitiis nitidis et distinctissime punctulatis, propodeo rugoso. Abdominis segmentum 2 dorsale fortissime (præcipue ♂) tuberculato-elevatum; ventrale post costas depressione sat lata et distincta, sed parum alta, signatum. ♂ ♀. Long. 8–10 m.m.

Sp. *O. erythrostactes*, qui insulam Maui incolit, affinis.

*Hab.* Puna, Hawaii.

VIII. *Four New Species and a New Genus of parasitic* Hymenoptera (Ichneumonidæ, *sub-fam.* Ophioninæ) *from the Hawaiian Islands.* By Robert Cyril Layton Perkins, B.A. Communicated by Dr. David Sharp, M.A., F.R.S.

[Read March 5th, 1902.]

The three new species of *Enicospilus*, Curt., as well as the more interesting form for which the genus *Abanchogastra* is created, are all found in the Koolau range of mountains on Oahu. The latter with the neuration of *Banchogastra*, Ashm., combines the cephalic and abdominal characters of many species of *Enicospilus*. It is probably a rare, and certainly a very inconspicuous species, several journeys to the locality where the first specimen, a ♂, was obtained having resulted in the capture of a single example of the other sex. Most of the Hawaiian Ophionines fly freely in the day-time as well as at night, and, made conspicuous by their activity, are more easily collected than many other native insects.

### *Abanchogastra*, gen. nov.

Eyes large, touching the base of mandibles or nearly, distinctly emarginate on a line with insertion of the antennæ ; ocelli large, the lateral ones touching the eye-margins, but distinctly separated from one another. Propodeum without a transverse carina. Claws of tarsi pectinate. Neuration almost as in *Banchogastra*, Ashm., the first recurrent nervure interstitial with the second transverse median nervure ; transverse median nervure in hindwings obtusely angularly broken about the middle ; discocubital nervure very regularly curved. Abdomen and legs as in most Hawaiian *Enicospilus*.

### *Abanchogastra debilis*, sp. nov.

♂ ♀. Length 8–9 m.m. Black ; face yellow, with a median longitudinal band in the ♀ testaceous ; palpi pale, teeth of mandibles black, posterior orbits yellow in both sexes, and the space between the ocelli of the same colour in the ♂, black in the ♀. Thorax

black, scutellum obscurely piceous, also the mesothorax in the ♀; prosternum pale; antennæ and legs testaceous; hind coxæ dark and the femora brown, tarsi fuscous in the ♂, pale in the ♀ with dark apical joints. Abdomen with basal segment black or brownish-black, second brown, the following paler than the second, the terminal ones more or less dark.

Face impunctate or nearly; antennæ in ♂ reaching beyond the apex of the wings when spread by about half the length of the latter, in ♀ shorter, but reaching beyond the apices of the wings. Mesonotum coriaceous, not evidently punctate. Propodeum densely rugulose posteriorly, much smoother in front, except along the middle, and with no transverse carina in either sex. Abdomen with the basal segment subclavate, a little longer than the second in dorsal aspect, the apical segments strongly compressed. Wings hyaline and iridescent.

*Hab.* Koolau range of Oahu.

*Enicospilus semirufus*, sp. nov.

♂ ♀. Length 17–21 m.m. Black; face in ♂ widely yellow along the orbits, in the middle, and the whole of the clypeus light brown or testaceous, in front of the anterior ocellus dark brown, occiput yellow with a dark brown band behind; the face in the ♀ has the orbits generally much more narrowly yellow, and between these is dark brown, and the occiput is much more extensively dark. Palpi dark, the terminal joint paler. Antennæ dark brown or blackish fuscous, scape sometimes of a paler colour. Thorax entirely and the legs black, tibiæ and tarsi dark brown or blackish fuscous. Abdomen with the petiole black, the second segment generally darker than the following, which are ferruginous, the terminal segments blackish.

Clypeus finely and closely but distinctly punctured; antennæ in ♂ half as long again as the wings, in the ♀ reaching to the apex. Mesothorax with fine close feeble punctures. Propodeum rugose (more coarsely in ♀), much more finely in front on the anterior third than behind, transverse carina wanting or indistinct in ♂, very well marked in ♀. Abdomen densely and very finely punctured on the sides, unusually dilated at the apex in the ♀ as compared with other species (e. g., *E. mauicola molokaiensis*, etc.) owing to the more exserted sixth ventral segment. Wings fusco-hyaline discocubital cell with one small blister-like spot.

*Hab.* Koolau range of Oahu.

Apparently closely allied to *E. kaalæ*, Ashm., but in the description of that species I find no reference to a sexual

difference in the transverse carina of the propodeum, and it further has the palpi pale and the tibiæ and tarsi rufous.

*Enicospilus dispilus*, sp. nov.

♂ ♀. 16–18 m.m. Black; face in ♂ brown or dark brown, clypeus and labrum pale ferruginous or yellowish, front and hind orbits pale yellow, the yellow of the latter discontinuous, not meeting behind the ocelli. Antennæ dark fuscous. Thorax and basal segment of the abdomen black, the third segment more or less evidently tinged with dull ferruginous, the rest blackish fuscous. Femora black, tibiæ and tarsi dark brown or fuscous, front tarsi sometimes paler.

Face finely and densely punctured, antennæ in ♂ extending beyond apex of the spread wings by a length about equal to that of the marginal cell, in the ♀ somewhat shorter; ocelli very large. Mesothorax finely and very densely punctured, propodeum with very dense rugulose sculpture which is evidently finer on the anterior third, the transverse carina very distinct in both sexes and shining. Wings fusco-hyaline with dark neuration, discocubital cell with a larger pear-shaped or subtriangular spot on the basal side of the hyaline hairless space, and a minute roundish one situated well within this space.

*Hab.* Koolau range of Oahu.

Extremely like *E. mauicola*, Ashm., except for the second spot in the discocubital cell and the less smooth surface of the anterior third of the propodeum.

*Enicospilus dispilus*, var. *pallipes.*

Hardly different to the type in the structure, but readily distinguished by the clear rufotestaceous antennæ, tibiæ and tarsi and the more or less rufescent femora.

*Hab.* Mountains of Kauai.

*Enicospilus dimidiatus*, sp. nov.

♀. Closely allied to and greatly resembling *E. mauicola*, Ashm., but differing in the following characters. It is much smaller, the length being only 11 m.m. The face is excessively finely and indistinctly punctate, the yellow lines along the anterior orbits extremely narrow, the antennæ are brown and not very dark-coloured. The propodeum posteriorly is much more finely rugulose, the transverse carina very faint, only perceptible on the middle third, being effaced at the sides. The wings are clearer.

*Hab.* Koolau range of Oahu.

## IX. *On the Generic Characters of Hawaiian* Crabronidæ; *four new genera characterized.* By Robert Cyril Layton Perkins, B.A. Communicated by Dr. David Sharp, M.A., F.R.S.

[Read March 5th, 1902.]

When describing the species of Hawaiian Crabronidæ in the "Fauna Hawaiiensis" I referred the bulk of the species to the subgenus *Solenius*, establishing a new genus *Nesocrabro* for the remainder. At that time I erroneously supposed the common European *Crabro vagus* to be the type of *Solenius*, and at the same time pointed out that the Hawaiian species would probably form several new genera. It still appears to me that the *Crabro vagus* is most closely allied to some of these species, but is not congeneric. Three of the Hawaiian species are evidently generically distinct from the others, each forming the type of a new genus, and two of these appear to me to be highly remarkable forms. The remaining species formerly referred to *Solenius* are still a rather ill-assorted lot, showing important differences in structure, but still may be conveniently included in a single genus. *Nesocrabro*, the peculiar genus previously characterized, is also a very distinct form, and in the table of generic characters given below it is included with the four other genera. I may add that I have not been able to add a single new species of Crabronidæ to the Hawaiian list during my present visit, and I imagine that very few species remain to be discovered. All the Crabronidæ of the islands belong to Ashmead's subfamily *Crabroninæ*, the other subfamilies being quite unrepresented. Of the Hawaiian genera I consider that the species of *Xenocrabro* probably most nearly resemble the type by which the islands were originally colonized, and that the other four are special developments in various directions from *Xenocrabro*, the development of generic characters having proceeded along much the same lines as is the case with Crabronids in other parts of the world. Thus *X. affinis* makes a distinct approach to the genus *Nesocrabro*, *X. monticola* to *Hylocrabro* in some important characters.

The following characters appear to be common to all the Hawaiian Crabronini:

♂ ♀. Ocelli in a triangle, which is much widest at the base, the posterior ocelli being nearly twice as far apart as either one is from the anterior ocellus; recurrent nervure received very near the apex of the cubital cell; superorbital foveæ at most represented by elongate smoother spaces, or shallow and often shining impressions.

♂. Antennæ 12-jointed, 3rd joint always long, much longer than the 4th, but shorter than the 4th and 5th together, not less than twice as long as the 2nd; 6th always emarginate beneath and produced more or less below the base of the 7th, often forming a very prominent tooth; spur of middle tibiæ well-developed; apex of mandibles always bidentate.

♀. Pygidial area always defined by distinct carinæ, but varying in form from more or less wide and triangular, to very narrow and elongate.

1. (2) Antennal fossæ in front view of the head well separated from the eye-margins by a space at least nearly as wide as one of the antennal forsæ.

   Clypeus with suberect hairs, the surface not concealed by dense appressed pilosity of metallic colour, the apex widely rounded; propodeum with a median sulcus. ♂ with the 6th joint of the antennæ very little produced beneath at the apex, not forming a strongly prominent tooth. ♀ with the 5th segment (except in one species) densely clothed with red hairs; mandibles 3-dentate at apex, the upper tooth generally not strongly developed, no post-median tooth on the upper edge; pygidial area very narrow and elongate.

   *Nesocrabro P.*

2. (1) Antennal fossæ in front view contiguous to the eye-margins; clypeus always hidden under a dense covering of silver or golden appressed pilosity.

3. (4) ♂. Sixth joint of the antennæ produced into a long tooth, appearing simple in one aspect, but it is really flattened and of subquadrate form; front legs much modified.

   *Oreocrabro*, gen. nov. (Type *Crabro abnormis*, Blackb.)

4. (3) ♂. With the 6th joint of the antennæ feebly or distinctly toothed, but the tooth not flattened and compressed.

5. (6) ♂. Second segment of abdomen beneath flattened and inclined at an obtuse angle to the flattened or impressed third segment; 6th joint of antennæ very little produced at apex, not projecting much below the base of the following:

abdomen above closely and evenly punctured, posterior tarsi very short, hardly as long as the tibiæ.

♀. Mandibles 3-dentate at apex, the post-median tooth of upper edge wanting, the edge at most a little sinuate, clypeus carinate and the apex rather widely emarginate; propodeum with a distinct consute groove dividing it from the postscutellum, smooth except for feebly-impressed nearly obsolete punctures and minute surface sculpture, no longitudinal wrinkles, calcaria of hind tibiæ much bent; abdomen with 2nd dorsal segment finely and closely punctured, beneath very tightly convex, the pygidial area long and narrow.

*Melanocrabro*, gen. nov. (Type *Crabro curtipes P.*)

6. (5) ♂. Second ventral segment lightly or strongly convex over most of its surface, not inclined at an angle to the following.

♀. Mandibles bidentate at apex, or if 3-dentate then there is a post-median small, but evident, tooth on the upper edge, and the 2nd ventral segment is very strongly convex.

7. (8) ♂. Second ventral segment very strongly convex in profile, generally more or less tumid; clypeus somewhat produced in front, its middle part subtriangular, somewhat widely truncated at the apex, 6th joint of antennæ with a very distinct prominent apical tooth; post-median tooth of upper edge of mandibles small.

♀. Mandibles 3-dentate at apex, with small post-median tooth on upper edge, clypeus somewhat produced and very distinctly emarginate at the apex; 2nd ventral segment very convex, tumid, or subtuberculate; pygidial area long and narrow; eye facets very coarse in front.

*Hylocrabro*, gen. nov. (Type *Crabro tumidoventris, P.*)

8. (7) ♂. Second ventral segment not strongly convex; if rather strongly, then the 6th joint of the antennæ is only very feebly or hardly visibly produced below the base of the following; clypeus with its anterior margin generally widely rounded, sometimes a little sinuate, rarely produced in front; post-median tooth distinct and sharp, often large.

♀. Mandibles bidentate and with post-median tooth of upper edge sharp and well-developed, clypeus often widely rounded at apex; if somewhat produced it has no distinct emargination; 2nd ventral segment simple, only lightly convex; pygidial area triangular, never very narrow and elongate, flat within the carinæ, or the middle part ob-

securely raised. Facets of eyes very coarse or finer, variable according to species.

Mesothorax with a very shallow median impression anteriorly, the sculpture of the front part dense, consisting of very feebly impressed, indistinct punctures, the surface dull, posteriorly sometimes more definitely punctate. Propodeum in front with minute granulate sculpture under a strong lens rather than punctured, generally with some fine longitudinal wrinkles or irregular ones, sometimes very short, rarely wanting. ♂ with the anterior femora, trochanters and tarsi simple ; the 6th joint of the antennæ very slightly or strongly produced at the apex according to the species.

*Xenocrabro*, gen. nov. (Type *Crabro unicolor*, Smith.)

X. *A Monograph of the genus* Acrida, Stål ( = *Truxalis*, Fabr.), *with Notes of some allied genera, and descriptions of new species.* By Malcolm Burr, B.A., F.L.S., F.Z.S., etc.

[Read March 5th, 1902.]

The following revision of the genus *Acrida*, Stål, better known as *Truxalis*, Fabr. (usually, and incorrectly, spelt *Tryxalis*), with the notes on certain allied genera, was written nearly eighteen months ago, when it was my intention to so revise the whole of the family *Truxalidæ*. I do not, however, at present see my way to completing the work, and so publish now the results of a study of the genus *Acrida*, Stål, which badly needed recasting, together with descriptions of a few new species of other genera, and a revision of the genus *Gelastorrhinus*, Br., which was previously ranged not in the *Truxalidæ*, but in the *Acridiidæ*; these were at the time taken in the stride in due course when studying the genera in order. I have, moreover, refrained from including notes upon the American genera, which have been well done by McNeill, Scudder, Brunner and others, especially as the latter author has been, and is still, occupied with these genera. Some of the African genera given in the synoptical table, are not otherwise referred to, for there is nothing as yet to add to the original descriptions of Karsch.

I have received help and assistance from various correspondents, but am especially grateful to Herr Hofrath Dr. C. Brunner von Wattenwyl, upon whose suggestion and kindly invitation, I originally went to Vienna to work at the *Truxalidæ* of his extremely rich collection. All the wealth of this finest of collections of Orthoptera were placed freely at my disposal, and much help and advice I received from this most experienced and distinguished entomologist.

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## *Dispositio Generum.*

1. Caput ascendens. Pronotum postice plus minus timidum. . . . . *Acrida*, Stål.

1.1. Caput haud ascendens. Pronotum postice haud tumidum.

2. Prosternum tuberculo parvo instructum. (Lobi metasternales contigui; caput cylindricum.)

3. Caput pronoto longius.
4. Foveolæ verticis angustæ. Elytra et alæ perfecte explicatæ. Tibiæ posticæ margine externo spinis 16 armatæ . . . . . *Achurum*, Sauss.
4.4. Foveolæ nullæ. Elytra rudimentaria; alæ nullæ. Tibiæ posticæ spinis 25 armatæ. . *Rhadinotatum*, McN.
3.3. Caput pronoto brevius, vel æque longum . . . . . *Gelastorrhinus*, Brunner.
2.2. Prosternum muticum, tuberculo nullo.
3. Caput conicum. Frons minus reclinata. Lobi metasternales haud contigui.
4. Vertex oculo longior. Elytra ♂ longitudine pronoti latiora. Alæ ♂ latissime fenestratæ . *Hyalopteryx*, Charp.
4.4. Vertex oculo brevior. Elytra ♂ longitudine pronoti angustiora. Alæ ♂ minus late fenestratæ . . . . . *Truxalis*, Fabr.
3.3. Caput subcylindricum, vel valde horizontaliter productum, haud conicum. Frons valde reclinata. Lobi metasternales contigui vel subcontigui.
4. Caput pronoto longius.
5. Statura gracillima. Alæ haud fasciatæ . . . . . *Calamus*, Sauss.
5.5. Statura robustiori. Alæ nigrofasciatæ . . . . . *Glyphoclonus*, Karsch.
4.4. Caput pronoto haud longius, sæpe brevius.
5. Elytra valde abbreviata (antennæ serratæ) . . . . *Odontomelus*, Bol.
5.5. Elytra perfecte explicata.
6. Alæ ♂ ♀ fenestratæ . . *Amphicremna*, Karsch.
6.6. Alæ ♂ ♀ haud fenestratæ.
7. Statura majore. Lobi acuminati femorum posticorum exteriores quam interiores multo

majores. Antennæ serratæ . . . . . *Oxyolena*, Karsch.

7.7. Statura minore. Lobi acuminati femorum posticorum interiores majores. Antennæ serratæ.

8. Caput rugis longitudinalibus instructum . *Amycus*, Stål.

8.8. Caput rugis nullis . . *Machæridia*, Stål.

## *Acrida*, Linn.

Caput in conum ascendentem elongatum ; oculi oblongi, a margine antico pronoti longe remoti. Fastigium verticis rotundatum, lateribus reflexis, cum fronte angulo valde acuto contiguum. Foveolæ verticis inferæ, angustissimæ, triangulares. Frons valde reclinata, ad ocellum medium subconstricta. Costa frontalis ad verticem acuta, inter antennas valde compressa, profunde sulcata, dehinc sensim obliterata. Antennæ capite longiores, compressæ et basi dilatatæ, ensiformes, segmento primo cylindrico, secundo parvo, aeque longo et lato, sequentibus valde compressis, triquetris, apicalibus 10 angustioribus, ultimo subcylindricis. Pronotum, a latere visum, concavum, postice triangulare (in *A. thrymmatoptera* exceptum, rotundato-truncatum), supra tricarinatum, carina media a sulco transverso unico interrupta, carinis lateralibus antice subparallelis, postice divergentibus, lobis deflexis rugis longitudinalibus interruptis instructis, angulo antico obtuso, postico acuto. Elytra angusta, acuminata, vena intercalata nulla. Alæ acuminatæ, angustæ, area a furca rami radialis inclusa dilatata, venulis transversis verticalibus, æque distantibus reticulata. Pedes graciles, postici longissimi, gracillimi. Femora postica vix incrassata. Segmentum abdominale primum utrinque fovea valde aperta instructum. Lamina supranalis in utroque sexu triangularis, obtusa, in larvis utriusque sexus valde elongata, compressa, acuminata. Lamina subgenitalis ♂ in processum cucullatum producta.

(*Gryllus*) *Acrida*. Linn., 1758, S.N., ed. x, i, p. 427.
*Truxalis*. Fabr., 1775, Syst. Ent., 279 ; Serv. Charp.
*Tryxalis*. Brullé, 1835, Hist. Nat. Ins., IX, 216 ; Fisch. Fr. Brunner et auctt.
*Troxallis*. Fisch. de W., 1846, Orth. Ross., p. 229.
*Acrida*. Stål, 1873, Rec. Orth., I, 95 ; Karsch, Bol., Sauss.

Stål was the first to restore Linnæus' name, of undoubted priority, and although Brunner refuses to accept

the alteration, Stål is followed by Karsch, Bolivar and de Saussure.

It is a difficult genus, and Stål's work by no means clears the difficulty. Bolivar, however, has to a great extent elucidated it.

## *Dispositio Specierum.*

1. Elytra in utroque sexu similia; areis mediastina et scapulari opacis, irregulariter reticulatis, haud ampliatis. Carinæ laterales prozonæ rectæ, parallelæ. Ungues tarsorum breves, arolio iis æque longo, apice dilatato, magno.
   2. Alæ læte rubræ vel aurantiacæ.
      3. Alæ fascia nigra ornatæ.
         4. Vertex ante oculos acute delineatus: caput et thorax unicoloria: fascia nigra apicem alarum attingens.
            5. "Statura mediocri vel magna. Fastigium plus productum, acutius." . . . . . 1. *Brunneriana*, Bol.
            5.5. "Statura minore. Fastigium minus productum, obtusius" 2. *Sanguinea*, Sauss.
         4.4. Vertex ante oculos deplanatus: caput et pronotum nigro-punctulata: fascia nigra marginem externam alarum liberans . . . . . 3. *Liberta*, sp. n.
      3.3. Alæ fascia nigra nulla.
         4. Alæ croceæ, apice hyalinæ . . 4. *Crocea*, Bol.
         4.4. Alæ aurantiacæ, nigro-tessellatæ . . . . . 5. *Ensis*, Burr.
   2.2. Alæ hyalinæ, vel infumatæ, vel flavescentes, vel albidæ.
      3. Alæ albidæ . . . . . 6. *Intercalata*, sp. n.
      3.3. Alæ hyalinæ.
         4. Alarum ramus venæ radialis primæ haud incrassatus, aream angustam includens.
            5. Carinæ pronoti parallelæ.

Femora antica pronoto longiora . . . . . 7. *Acuminata*, Stål.

5.5. Carinæ pronoti postice sensim divergentes; femora antica pronoto breviora.

6. Caput et pronotum fortiter carinulata. . . . . 8. *Carinulata*, Bol.

6.6. Caput et pronotum lævia. 9. *Nasuta*, Linn.

10. *Rufescens*, Pal.

4.4. Alarum ramus venæ radialis primæ incrassatus, aream latam includens.

5. Vena incrassata alarum flexuosa, apice recurva, vena ulnari contigua (alæ sulphureæ) . . . . . 11. *Sulphuripennis*, Gerst.

5.5. Vena incrassata alarum subrecta, apice recurva, venam ulnarem liberans.

6. Carinæ pronoti parallelæ . 12. *Stali*, Bol.

6.6. Carinæ pronoti postice divergentes.

7. Alæ infumatæ. Species asiaticæ.

8. Alæ hyalinæ, basi nigro-tesselatæ. Femora antica pronotum longitudine æquantia . . . . 13. *Lugubris*, sp. n.

8.8. Alæ hyalinæ, totæ leviter infumatæ: femora antica pronoto longiora . . . 14. *Brevicollis*, Bol.

7.7. Alæ flavescentes. Species africanæ.

8. Alæ leviter flavescentes. Femora antica pronotum æquantia . . . . 15. *Subtilis*, sp. n.

8.8. Alæ hyalinæ, haud coloratae: femora antica pronoto longiora . . . . . 16. *Propinqua*, sp. n,

1.1. Elytra in ♂ areis mediastina et scapulari ampliatis, hyalinis, venulis transversis regulariter dispositis, reticulatis. Carinæ laterales prozonæ flexuosæ. Ungues tarsorum articulo tertio parum breviores, arolio compresso, brevissimo.

2. Statura maxima (♀ 92 mm.); alæ valde abbreviatæ. Fastigium verticis latum; pronotum postice rotundato-truncatum . . . . . 17. *Thrymmatoptera*, [Karsch.

2.2. Statura mediocri. Alæ haud abbreviatæ. Fastigium verticis angustius. Pronotum postice acutangulum.

3. Carinæ pronoti antice subrectæ. Pronotum postice acutangulum. 18. *Variabilis*, Klug.

3.3. Carinæ pronoti valde flexuosæ. Pronotum postice in spinam acutam productum.

4. Alæ fusco-fasciatæ . . . . . 19. *Fusco-fasciata*, Bol.

4.4. Alæ haud fasciatæ.

5. Alæ basi flavescentes, hyalinæ. Antennæ marginibus integris . . . . . 20. *Serrata*, Thunb.

5.5. Alæ sanguineæ, nigro-tessellatæ. Antennæ marginibus serratis . . . . . 21. *Somalia*, sp. n.

## 1. *Acrida brunneriana* (Bol.).

Viridis, fusco- vel rufo-variegata. Statura gracili: mas feminâ duplo minor. Antennæ ensiformes, elongatæ, ♂ capite et pronoto unitis longiores, lateribus serratis. Caput angustum, vix elevatum; vertex ante oculos acute delineatum, fastigium lateribus vix reflexis, vix concavum. Pronotum cylindricum, carinis lateralibus subrectis, postice subundatis, margine postico acutangulo: lobi deflexi carina superiori recta: pronotum postice sub-dilatatum. Caput et pronotum viridia, fusco- vel testaceo-variegata, linea albida ab oculis per genas lobosque deflexos perductâ ornata: carinæ nigro-ornatæ. Elytra angustissima, viridia, fusco-variegata, areis mediastina et scapulari haud dilatatis. Alæ basi albidæ, vel flavescentes, medio læte rubro, extus fascia lata nigra apicem ipsum liberanti, margine

exteriori maculis nonnullis albidis, ornatæ. Femora antica pronoto longiora: ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 31–34 m.m. | 51–53 m.m. |
| ,, antenn. . . . . | 15–5 | 21–22 |
| ,, pronoti . . . . | 4–4·5 | 8 |
| ,, elytrorum . . . | 29 | 48–53 |
| ,, fem. ant. . . . | 6 | 9 |
| ,, fem. post. . . . | 20·5 | 39 |

*Patria.* Central Madagascar (Bol., Coll. Brunner, No. 13,823); Tananarive (Coll. Brunner, No. 17,874).

*Truxalis brunneriana.* Bol., 1893, Det. Gen. Tryx., 1 and 3.
*Acrida radamæ.* Sauss., 1899, Senck. Nat. Ges., xxi, 629, pl. xxxviii, figs. 29, 30.

Bolivar gives a very brief description of the species, under the name received from de Saussure. The specimens in the Brunner collection are named "*brunneriana*," but there can be no doubt that de Saussure changed his name on publishing the description. In the meantime Bolivar had gained priority and his name must stand. The specimens in the Brunner collection named "*brunneriana*" by de Saussure agree perfectly with the latter's description, and there is no doubt as to the correctness of the synonymy.

It varies considerably in size and intensity of colour. The male is very markedly smaller than the female.

### 2. *Acrida sanguinea*, Sauss.

Quam *A. brunneriana* minor. "Caput minus elongatum; ejus processus a latere minus angustus, multo minus elongatus, verticisque rostro breviore. Pronotum illo *A. turritæ* (*T. nasutæ*) sat simile, carinis dorsalibus lateralibus in metazona divergentibus. Elytra et alæ angustissima, acutissima. Color viridis, subtus pallidus. Caput subtus lutescens, utrinque inter carinas laterales vitta lutea vel rubrescente ab ocula emissa ornatum, necnon superne utrinque vittam alteram albidam ab oculo inter carinas supernas ad apicem pronoti præbens. Margo inferior loborum lateralium anguste albo-limbatus. Elytra longissima, viridia. Alæ et ad basin sanguineæ; campi antici apice leviter decolore vel virescente; margine externo campi postici per vittam fuscam limbato; vitta antice latiuscula, postice valde angustata.

Var. *a.* Caput et pronotum vitta dorsali longitudinali lutea. Var.

*b.* in desiccatis nonnunquam alæ decolores flavicantes, vel tantum anterius sanguineæ. ♀ long. corp. 53 ; caput supra 13 ; pronoti. 7 ; elytr. 54 ; fem. post. 33 m.

*Acrida sanguinea.* Sauss., 1899, Senck. Nat. Ges., xxi, 629.

*Patria.* Antananarivo in MADAGASCAR (*Sauss.*).

I only know this species from de Saussure's description. It appears to be very closely allied to *A. brunneriana.*

### 3. *Acrida liberta*, sp. n.

Viridis ; statura majore. Caput, pronotum, sternum et pleuræ nigro-punctulata. Vertex latus, deplanatus, haud acute delineatus, lateribus valde reflexis. Antennæ valde deplanatæ, longæ. Pronotum postice haud dilatatum, carinis lateralibus parallelis, rectis ; disco medio puncto nigro utrinque ornatum : lobi deflexi carinulis irregularibus instructi. Elytra longa, angusta, valde acuminata. Alæ elytris breviores, rubræ, apice hyalinæ, nigrofasciatæ ; fascia nigra marginem posticum alarum includens, apicem liberans. ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 75 m.m. |
| ,, antennæ . . | 23 (broken). |
| ,, capitis . . . | 16·5 |
| ,, pronoti . . | 10 |
| ,, elytrorum . | 64–25 |
| ,, fem. ant. . . | 13·5 |
| ,, fem. post. . . | 42 |

*Patria.* SLAVE COAST, Hó (Coll. Brunner, No. 17, 438).

This species differs from *A. brunneriana* in the form of the vertex and the alar fascia, which is curved inwards towards the apex, leaving the apex of the wing clear. From *A. crocea*, it may be easily distinguished by the presence of the black band.

### 4. *Acrida crocea* (Bol.).

Viridis vel rufa. Vertex ante oculos deplanatus, haud acute delineatus. Fastigium verticis antrorsum ampliatum, latissimum, supra concavum, marginibus reflexis. Antennæ valde ensiformes, deplanatæ, ♂ dimidio basali latiores, dimidio apicali angustatæ, ♀ in tertia parte apicali tantum angustatæ. Pronotum angustum, nec dilatatum nec elevatum, carinis lateralibus parallelis, postice acutangulum ; lobi deflexi carinâ superiori subsinuatæ. Elytra

valde acuminata, opaca, viridia vel rufescentia, areis mediastina et scapulari in utroque sexu opacis, haud dilatatis. Vena radialis postica in medio elytri furcata. Alæ elytris breviores, læte croceæ, maculis nonnullis pallidioribus ornatæ, apice tantum hyalinæ vel flavescentes. Femora antica pronoti longiora : femora postica elytris breviora : ungues tarsorum breves, arolio elongato. Lamina subgenitatis ♀ acuminata. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corporis . . . | 45–55 m.m. | 66–75 |
| „ antennarum . . | 20 | 27 |
| „ pronoti . . . | 7–8 | 10 |
| „ elytrorum . . | 41·75–52 | 68 |
| „ fem. ant. . . . | 7·75–9 | 10–12 |
| „ fem. post. . . | 29·5 | 35·5 |

*Truxalis crocea.* Bol., 1889, Ort. Mus., Lisbon, p. 91.
Bol., 1893, Det. Gen. Tryxalis, pp. 1 and 3.

*Patria.* ANGOLA, Duc de Bragança; Ambriz (*Bol.*); PORT NATAL, Duc de Bragança; TRANSVAAL (Coll. Brunner, Nos. 2304, 15,398).

The specimens in the Brunner collection are somewhat smaller than the type of Bolivar.

It may be distinguished by the colour of the wings : it falls obviously into the first division of the genus, and is not likely to be confused with its allies.

The cell on the pronotum is sometimes present, and sometimes obsolete.

### 5. *Acrida ensis* (Burr).

Viridis. Corpus elongatissimum, cylindricum. Caput minus ascendens ; antennæ longæ, deplanatæ, segmentis apicalibus minoribus, capite pronotoque unitis longiores. Pronotum parvum, cylindricum, nec constrictum nec postice dilatatum : carinæ laterales subflexuosæ, postice paullo divergentes ; sulcus typicus valde pone medium situs, sinuatus ; lobi laterales pronoti antice obtuse-angulati, haud rotundati, carinis cum carinis dorso-lateralibus pronoti pæne parallelis. Sternum medio valde carinatum. Elytra longissima, acuminata viridia, area scapulari venulis transversis obliquis sat remotis venulaque spuria instructa. Alæ pulcherrimæ, longæ, angustæ, elytris valde breviores, aurantiacæ, nigro-tesselatæ, apice flavido-hyalinæ. Abdomen typicum. Pedes longissimi, gracillimi ; tarsorum urgues longi ; pulvillo magno. ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 53–63 mm. |
| „ antenn. . . | 24 |
| „ capitis . . | 14·5 |
| „ pronoti . . | 8–8·25 |
| „ elytrotrum . | 52·57 |
| „ alarum . . | 46 |
| „ fem. post. . | 37 |
| „ tib. . . . . | 36·75 |

(?) *Tryxalis nasuta.* Burr, 1898, P.Z.S., 284 (larvæ).
*Truxalis ensis.* Burr, 1899, Bull. Mus., Liverp., ii, 43.

*Patria.* Sokotra (B. M. Mus., Liverp.).

This is one of the two most elongated and slender members of the genus: it should be noticed that the antennæ exceed the combined length of the head and pronotum: the golden-orange wings, tesselated with black, are very striking.

### 6. *Acrida intercalata*, sp. n.

Statura minore. Testacea. Vertex latus, deplanatus, haud acute delineatus, lateribus paullo reflexis. Pronotum postice haud dilatatum, carinis lateralibus parallelis; lobi deflexi angulo postico acuto. Elytra testacea, angusta, valde acuminata. Alæ angustæ, totæ albidæ. Pectus carinatum. ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 48 m.m. |
| „ antenn. . . | ? |
| „ pron. . . . | 7·5 |
| „ elytr. . . . | 43 |
| „ fem. post. . | 30 |

*Patria.* Central Madagascar (Coll. Brünner, No. 14, 871).

### 7. *Acrida acuminata*, Stål.

Virescens, vel testacea. Statura fortiori. Caput haud elevatum; fastigium verticis latum, lateribus haud fortiter reflexis; antennæ capite et pronoto unitis breviores. Pronotum nigro-vittatum, carinis lateralibus rectis, parallelis, mesosternum carinis tribus, media recta, lateralibus antrorsum convergentibus, instructum. Elytra angusta, valde et fortiter attenuata, acuminata, testacea fusco-variegata. Alæ angustæ, citrinæ, valde acuminatæ, apice fusco-radiatæ, vena radiali furcata, aream latam formanti, regulariter reticulatæ. ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 69 m.m. |
| „ antenn. . . | 24·5 |
| „ capitis . . | 14–15 |
| „ pronoti . . | 10·5 |
| „ elytrorum . | 58 |
| „ fem. post. . | 39 |

*Acrida acuminata.* Stål, 1873, Rec. Orth., i, 97.
Bol., 1881, Ins. Angola Mus. Lisb., 10.

*Tryxalis acuminata.* Bol., 1893, Det. Gen. Tryx., 1–3.
Bol., 1893, Ann. Soc. Ent. Fr., 174.

*Patria.* Caffraria (*Stål*, Mus. Holm.); Gaboon (Coll. Brunner, No. 13,261); Port Natal, near Ladysmith (Coll. Brunner, No. 16,729); Bathurst, Assinie (*Bol.*).

The extremely pointed elytra, the yellow wings, radiated with brown at the extremity, the thickset, flattened head and pronotum, distinguish this species.

### 8. *Acrida carinulata* (Bol.).

"Pallide rufescens (verisimiliter decolorata). Fastigium verticis concavum, marginibus reflexis. Caput supra subtusque longitrorsum carinulatum, inter carinas rugoso-granosum. Antennæ modice ampliatæ. Pronotum granulosum, pone sulcum posticum parum ampliatum, carinis punctato-impressis, ante sulcum rectis, parallelis; pone sulcum lævissime curvatis, valde distantibus; sulco pone medium sito; margine postico obtuse angulato; carina media acute producta; lobis deflexis retrorsum modice ampliatis, margine externo valde incrassato, fere recto, intus carina longitudinali cum carina marginali dorsi parallela, in prozona fere oblitteratæ. Elytra angusta, longissima, valde acuminata vena radiali tertia ante medium elytri furcata, deinde haud ramosa; vena intercalari basi apiceque oblitterata. Alæ hyalinæ, angustæ, acuminatæ; ramo primo venæ radialis ante medium furcato. Pectus haud carinatum. Femora antica pronoto breviora; postica angulis apicalibus dorsalibus modice productis; arolio magno. ♀.

| | |
|---|---|
| Long. corp. . . . | 73 m.m. |
| „ antenn. . . | 22 |
| „ pron. . . . | 11 |
| „ elytr. . . . | 68 |
| „ fem. ant. . . | 9 |
| „ fem. post. . | 41 |

Esta especie pertenece á la primera division de Stål y debe figurar al lado del *Tr. acuminata*, Stål, de la que se distingue por la forma

relativemente mas prolongada y estrecha del pronoto y por la escultura de este y de la cabeza, esta última presenta numerosas quillas longitudinales no todos igualmente elevadas, distinguiendose ademas de la central otras dos á cada lado que parten del ojo y se continuan con la quilla lateral del pronoto y con el borde inferior lateral respectivamente ; entre estas quillas hay otras menos elevadas y mas irregulares, como formadas por granos dispuestos en series frecuentemente interrumpidas. El pronoto tambien esta cubierto de granos que sobre la metazona forman lineas longitudinales. Los élitros son muy largos y estrechos terminando en punta aguda ; la tercera vena radial se divide en dos antes del medio, casi el mismo nivel que la ulnaria anterior, continuando los ramos de la primera sin nueva division mientras que el ramo anterior de la ulnaria se bifurca una vez : la vena intercalada disaparece cerca de la base y tambien en el extremo del area que recorre, que es abierta. Las alas son hialinas, agudas, estrechas y una quinta parte mas contas que los élitros. Las patas posteriores son muy largas y delgadas."

*Tryxalis carinulata.* Bol., 1890, Orth. Afr. Mus., Lisboa, i, p. 90.
*Tryxalis carinulata.* Bol., 1893, Det. Gen. Tryx., 2 and 3.

*Patria.* Cape Verd Islands (*Bol.*).

I do not know this species and so merely quote Bolivar's description and remarks.

### 9. *Acrida nasuta,* Linn.

Viridis unicolor, vel roseo- et fusco-vittata, vel testacea. Elytra interdum in area discoidali serie vittarum albidarum, venam intercalatam simulante, ornata. Fastigium verticis supra concavum, haud acute delineatum. Antennæ usque ad apicem depressæ. Pronotum disco pone sulcum transversum vix dilatato, sensim elevato. Elytra areis mediastina et scapulari in utroque sexu opacis, venulis irregularibus obsitis, area anali angusta. Alæ hyalinæ, viriscentes, venis principalibus rufescentibus, in varietate testacea apice fusco-circumdatis. Femora antici pronoto breviora. Lamina subgenitalis ♂ lanceolato-acuminata, margine superiore sinuato.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 36–46 m.m. | 52–64 m.m. |
| ,, pron. . . . . | 5·5–8 | 8–11 |
| ,, elytr. . . . . | 28–40 | 45–62 |
| ,, fem. ant. . . . . | 5·7 | 6·6·9 |
| ,, fem. post. . . . . | 26–28 | 30–38 |

*Gryllus* (*Acrida*) *nasutus.* Linn., 1754, Syst. Nat., ed. x, i, p. 427 (♂ : ♀ = *unguiculata*, Ramb.).
Linn., 1764, Mus. Lud. Ulr., p. 118.
Stoll., 1787–1815, Représ. Tab., viii, b., fig. 27 (antennis falsis).

*Truxalis nasutus.* Fabr., 1793, Ent. Syst., ii, p. 26.
Rossi, 1790, Faun. Etrusca, i, p. 263.
Thunb., 1825, Mem. Ac. Sci. Pet., v, 264.
Latr., 1804, Hist. Nat. Crust. Ins., xii, p. 147, tab. 94, fig. 5, id.
Latr., Gen. Crust. Ins., iii, p. 103.
Cuvier, 1846, Regnè An., tab. 84, fig. 2 ; tab. 85, fig. 1.

*Truxalis nasuta.* Charp., 1825, Horæ Ent., 126.
Burm., 1839, Handb., ii, 606.
Serv., 1839, Orth., 580.

*Tryxalis nasuta.* Brullé, Hist. Nat. Ins., ix, 217.
Fisch., 1853, Orth. Eur., 299, tab. xv, fig. 1, 1a, b. 2.
Friv., 1868, Mon. Orth. Hung., 137, tab. vi, fig. 3.
Luc., 1849, Expl. de l'Alg. Orth., 25.
Fieb., 1853, Syn. 8 ; Ergänz. Lotos., 1854, 177.
Eversm., 1859, Bull. Soc. I. Moscow, xxxii, 131.
Brunner, 1882, Prod., 88.

*Truxalis pellucida.* Klug., 1830, Symb. Phys., tab. xviii, figs. 5–9.

*Acrida turrita.* Stål, 1873, Rec. Orth., i, 96.
Bol., 1878, Ort. de Esp., 102, tab. ii, figs. 14, 15.
Dubr., 1879, Ann. Mus. Civ. Gen., xii, 12.

*Acrida testacea.* Stål, 1873, Rec. Orth., i, 96.

*Acrida nebulosa.* Ibid., p. 96.

*Acrida bicolor.* Ibid., p. 97.

*Acrida conica.* Ibid., p. 98.

*Acrida nasuta.* Bol., 1878, An. Soc. Esp. H. N., vii, 461.
Pantel., 1886, An. Soc. Esp., H. N., xv, 266.
Bol., 1898, Cat. Sin. Ort. Faun. Ib., 43.
Karsch, 1887, Ent. Nach., xiii, 39.
Sulz., Kennt., tab. viii, fig. 57 (antennis falsis).
Rösel., Ins. Bel., ii, tab. iv, figs. 1, 2 (antennis falsis).
Savigny, Descr. Egypt. Orth., tab. v, figs. 3, 4, 5.

*Truxalis rafflesii.* Blanchard, Voy. Pol. Sud. Orth., iv, p. 366.

*Truxalis nasuta.* Linn., *var.*, id. op. cit., pl. 2, figs. 3–4 (18 . .).

*Truxalis gigantea.* Fuessly, 1794, Arch. (French trans.), p. 173, pl. 52, fig. 6, ♀.

*Acrida turrita.* Dubr., 1878, Ann. Mus. Civ. Gen., xi, 331.
Karsch, 1891, Berl. Ent. Zeit., xxxvi, 176.
Id., 1893, Orth. von Adeli, 55.
Marquet, 1898, Orth. Languedoc, 9.
Sauss., 1899, Senck. Nat. Ges., xxi, 630.

*Troxallis nasuta.* Fisch. de W., Orth. Ross., 231, tab. x, figs. 1, 2.

*Gryllus* (*Acrida*) *turritus.* Linn., 1854, Syst. Nat., ed. x, 427; ed. xii, 692.
Villers, Linn. Ent., i, p. 434, tab. ii, p. 4.

*Tryxalis turritus.* Krauss, 1878, Orth. Faun. Istriens, 26.

*Truxalis hungaricus.* Fab., 1793, Ent. Syst., ii, 27.
Herbst, Fuessly, 1786, Arch., tab. 52, fig. 7.
Germar., Reise, 1817, Dalm., p. 260.

*Truxalis unicolor.* Thunb., 1815, Mém. Ac. Pet., v, 263.

*Truxalis cinereus.* Thunb., 1827, Nov. Act. Ups., ix, 79, ♂.

*Truxalis testaceus.* Thunb., 1815, Mém. Ac. Pet., v, 263; id. 1827, Nov. Act. Ups., ix, 81.

*Truxalis nebulosus*, var. *a.* Thunb., 1815, Mém. Ac. Pet., v, 267; id. 1827, Nov. Act. Ups., ix, 83.

*Truxalis bicolor.* Thunb., 1815, Mém. Ac. Pet., v, 267; id. 1827, Nov. Act. Ups., ix, 87.

*Truxalis interruptus.* Thunb, 1815, Mém. Ac. Pet., v, 269.

*Truxalis conicus.* Thunb., 1827, Nov. Act. Ups., ix, 87.

*Tryxalis nasuta.* Bol., 1893, Ort. de Esp., p. 17; id. 1893, Det. Gen. Tryx., 304; 1894, Bull. Soc. Ent. Fr., clxi.
Burr, 1897, Tr. Ent. Soc., London, 44.
Bucchich, 1885, Verh. k. k. Zool.-Bot. Ges. Wien., 381.
de Bormans, 1885, Ann. Mus. Civ. Gen. (2), ii, 102.
Cuzurro, 1888, Ann. Soc. Esp. H. N., xvii, 473.
Eversm., 1859, Orth. Volg.-Ural., 131.
Friv., 1868, Mon. Orth. Hung., 137.

Gerst., 1873, Beitr. zur Ins. F. Sans., 215.
Giglio, Tos., 1893, Boll. Mus. Tor., No. 164, p. 5.
Griffini, 1897, Note Faune Piem., xi, 2.
Novak., 1883, Orth. Les., 125.

*Tryxalis nasutus.* Bonn. Fin., 1885, Orth. Tunis., 23.
*Truxalis nasuta.* Burr, 1899, Ent. Mo. Mag. (2), 10.
Charp., 1841, Germ. Zeitschr. f. Nat., iii, p. 305.
Finot, 1883, Cat. Orth. France, 6.
Id., 1883, Orth. Fr., 46.
Id., 1897, Orth. de l'Alg.-Tunis., 44.
Graber, 1870, Faun. Stud. Syrm., 377.
Krauss, 1887, Derm. Orth. Siciliens., p. 10.
Krauss, 1890, Erklärung Savigny's Egypt, 251, 252.
Pančić, 1883, Orth. Serb., 46.
Redt, 1889, Orth. Oestr., 23.
Redt, 1900, Derm. Orth. O.-Ung. Deutschland, 44.
Retowski, 1888, Bull. Soc. Imp. Mosc., 409.
Schult., 1898, Zool. Jahrb., viii, 73.
Schult., 1898, Orth. Somali., 185.
Werner, 1898, Verh. k. k. Zool.-Bot. Ges. Wien., p. 154.
Zub., 1896, Hor. Soc. Ent. Ross., xxx, 184.
Zub., 1898, Ann. Mus. Zool. Ac. Imp. Sci. Pet., 70.

*Truxalis nasuta.* Krauss, 1892, Wien. Ent. Zeit., 148.
Schaum., 1862, Peters' Reise Mossamb. Ins., 129.

*Patria.* In EUROPE: All Southern Europe, very common. The most northerly points of its distribution appear to be Budapest, the southern slopes of the Alps, and the south of France, Marseilles, Montpellier (Coll. Br.), the whole of the Balkans, and South Hungary (common), Italy, Sicily. In AFRICA: Algeria, Tunis, Egypt Senegal, Sierra Leone, Cameroons, Gaboon, South Africa, Natal, Cape Colony, Madagascar. In ASIA: Asia Minor, Syria, Turkestan, Himalaya, China, Hong-Kong, Hainan, Japan, Cambodia, Cochin China, Malaccas, Singapore, Celebes, Sumatra, Bangkok, Java, Borneo, Philippines. In AUSTRALIA: Rockhampton, Queensland, Sydney, Moreton Bay, Lord Howe's Island, Port Adelaide, Victoria, New Holland.

### 10. *Acrida rufescens* (Pal.).

"*Truxale* roussâtre. Antennes, tête, elytres variés on rayés de brun. Abdomen et pieds roussâtres. (Fig. 2.)

"*Truxalis rufescens.* Antennis, capite, elytrisque fusco-variegatis. Abdomen pedesque rufescentes. (Fig. 2.)

"Aux mêmes lieux que la précédente (nasutus, *i. e.* Chama, Oware and Benin), sur le bord des eaux.

"*Obs.* Rigoureusement parlant, cette espèce ne diffère de la verte (i. e. *nasutus* Fabr. et Linn.) que par sa couleur ; cependant, toutes proportions gardées, les antennes sont plus longues, et les sept ou huit derniers articles sont cylindriques, et cessent d'être plâts et triangulaires comme les inférieurs. J'en possède deux variétés : une dont les elytres sont marquées latéralement d'une large raie brune, tâchetées de blanchâtre et dans laquelle se trouve une nervure brune, interrompue alternativement de taches longues et blanchâtres : ce qui semblerait la rapprocher de la *Truxale conique*, *Truxalis conicus*, Fab. L'autre a les elytres entièrement rousses, d'une couleur plus pâle, uniforme et comme mouchetées de taches brune, mais peu apparentes."

*Truxalis rufescens.* Pal., 1805, Ins. Afr. Amér. Orth., pl. 2, p. 17, fig. 2.
*Acrida rufescens.* Stâl, 1873, Rec. Orth., i, p. 97.
*Truxalis nebulosus*, var. *d.* Thunb., 1815, Mém. Ac. Pet., v, p. 267 ; id. 1827, Nov. Act. Ups., ix, p. 83.
*Tryxalis rufescens.* Bol., Jorn. Sci. Math. Phys. e Nat., Lisboa (2), i, p. 92, 1890.

This remains a doubtful species ; if it really deserves specific rank, it must fall near to *Acrida nasuta*, L., but I am unable to differentiate in the synoptical table. Bolivar (l. c.) appears also in doubt.

I have given above Palisot de Beauvois' remarks in detail. Bolivar refers, with some hesitation, to this species some large specimens from Duque de Bragança.

Stâl remarks that it is very similar to *A. turrita*, but larger. In all probability it is merely a synonym of the type species.

### 11. *Acrida sulphuripennis* (Gerst.).

Viridis vel testacea. Mas feminâ duplo minor. Caput magis elevatum. Fastigium angustum, concavum. Antennæ haud valde deplanatæ, capite et pronoto unitis breviores. Pronotum subconstrictum postice subdilatatum, carinis lateralibus subsinuatis ; lobi deflexi angulo postico minus acuminato. Elytra viridia, vel testacea, fusco-variegata. Alæ flavæ, latiores, haud valde acuminatæ, area

dilatata valde perspicua, apice infuscatæ. Abdomen sordide flavidum vel fuscum. Lamina subgenitalis ♂ fornicata, bituberculata. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 33·5 | 53 |
| „ antennæ . . . | 11·5 | 19 |
| „ pronot. . . . | 5 | 8·5–10 |
| „ elytrorum . . | 21 | 52 |
| „ fem. post. . . | 20 | 37 |

*Tryxalis sulphuripennis.* Gerst., 1873, Van der Decken's Reise, iii (2), p. 33, tab. iii, fig. 1.
Gerst., 1873, Beitr. Ins. Faun. Zanz., 215, Arch. f. Naturf., xxv.
Bol., 1889, Orth. Afr. Mus. Lisboa, i, 93.
Id. 1893, Det. Gen. Tryx., 2 and 3 (nec Stål).

*Acrida sulphuripennis.* De Bormans, 1881, Ann. Soc. Ent. Belg., xxv, Orth.

*Patria.* Zanzibar (*Gerst.*), Duque de Bragança, and Lourenço Marques (*Bol.*), Zanzibar (Coll. Brunner, No. 10, 264), Lower Congo (Coll. Seeldrayers, Coll. mea.), South Africa (*Borm.*).
Very close to *A. ståli*, Bol.

## 12. *Acrida ståli* (Bol.).

Statura majore. Tota viridis; antennæ rufescentes, tantum basi dilatata apud ♂, post medium apud ♀. Alæ flaviscentes, hyalinæ. Elytra femora postica ♂ paullo superantia, ♀ valde superantia, acuminata; pronotum carinis rectis, parallelis; lobi deflexi carina superiori antice cum carinis dorsalibus parallela. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 45 m.m. | 70 m.m. |
| „ pronot. . . . . | 6.5 | 12 |
| „ elytr. . . . . | 33 | 60 |
| „ fem. post. . . . | 26 | 40 |

*Acrida sulphuripennis.* Stål (nec Gerst., nec Bol.), 1873, Rec. Orth., 95.
*Tryxalis ståli.* Bol., 1893, Det. Gen. Tryx., 2 and 4.

*Patria.* Senegal, Gulf of Guinea (*Bol.*), Sierra Leone (*Stål, Bol.*).

I do not know this species, and merely give the details

as given by Bolivar. It appears to be very nearly allied to *A. sulphuripennis*, Gerst.

### 13. *Acrida lugubris*, sp. n.

Statura mediocri: Viridis vel testacea, fusco-variegata. Vertex ante oculos deplanatus, lateribus haud valde reflexis. Antennæ breves, dimidio basali tantum paullo dilatatæ. Pronotum plus minus constrictum, postice dilatatum, margine postico acutangulo: carinæ laterales sinuatæ: lobi deflexi angulo postico haud acuto, rotundato. Elytra latiora, apice obtuse-acuminatæ, viridia vel testacea nigro- et albido-ornata. Alæ hyalinæ, costâ frontali paullo infuscatâ, basi infumatæ, fusco-tesselatæ. Elytra ♂ ♀ femora postica vix superantia. Lamina subgenitalis ♂ elongatum, angustum, supra basi bituberculatum. Mas feminâ multo minor.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 32·5–35·5 m.m. | 54·5–64·5 m.m. |
| „ antenn. . . . | 10·5 | 14–16 |
| „ pron. . . . | 4·75–5·5 | 10–10·75 |
| „ elytr. . . . | 27·5–28 | 46–51 |
| „ fem. post. . . | 20·5–22 | 32–37 |

*Patria.* East Indies (Coll. Brunner, ex coll. Fieber, No. 9382); Ceylon: Tungalle (Nos. 5696 and 15,556), and Colombo (Coll. Brunner, Nos. 5696, 15,556, 16,252 and 17,258); Bombay (Coll. Brunner, No. 16,192); Sikkim (Coll. Brunner, No. 22,846); South Celebes: Samanga and Patuhuang (Coll. Brunner, No. 20,768).

The specimens in the Brunner collection are labelled "*Tr. lugubris*, Fieb." and "*Tr. lugubris*, Br.," but the species has not hitherto been described.

The finest-coloured and largest specimens are from the north of Ceylon.

### 14. *Acrida brevicollis* (Bol.).

Statura minori. Viridis vel testacea. Antennæ breves, caput et pronotum unitis vix longiores. Pronotum subconstrictum, postice dilatatum, carinis lateralibus flexuosis, lobi laterales angulo postico subrecto. Elytra minus angusta, apice obtuse acuminata. Alæ hyalinæ, prope basin leviter infumatæ. Lamina supraanulis ♂ caniculatæ.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 28–38 m.m. | 50–59 m.m. |
| „ antenn. . . . | 9·5 | 17 |
| „ pron. . . . | 5–5·5 | 8·75–11 |

| | ♂ | ♀ |
|---|---|---|
| Long. elytr. . . . . | 25–30 m.m. | 45–50 m.m. |
| „ fem. post. . . . | 18·75–23 | 32–57 |

*Tryxalis brevicollis.* Bol., 1893, Det. Gen. Tryx., 2 and 4.

*Patria.* East Indies (*Bol.*): Maduré (*Bol.*), East India (Coll. Brunner, Nos. 13,259, 14,747, 2855, 5522, 16,014, 7391, 13,018), Silhet (Coll. Brunner, No. 6356); Ceylon (Coll. Brunner, Nos. 6253, 15,556, 16,105, 15,869): Colombo (Coll. Brunner, No. 16,668).

Very closely allied to *A. nasuta;* may be distinguished by the venation of the wings.

15. *Acrida subtilis,* sp. n.

Statura minore. *A. brevicolli* (Bol.) ægre distinguenda: ab ea differt, alis totis flavescentibus, nec infumatis, lamina supraanali ♂ non caniculata, apice rotundata.

| | ♂ |
|---|---|
| Long. corp. . . . . | 31–32 m.m. |
| „ antenn. . . . | 11 |
| „ pron. . . . . | 5–5·5 |
| „ elytr. . . . . | 25·75–26·5 |
| „ fem. post. . . | 19–20 |

*Patria.* Madagascar (Coll. Brunner, No. 14,870).

Very close to *A. brevicollis,* but the wings are very different; the antennæ also are slightly longer.

16. *Acrida propinqua,* sp. n.

*A. lugubri* vicina: ab ea differt alis hyalinis, pronoto vix constricto. Species africana.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 30 m.m. | 48·5 m.m. |
| „ antenn. . . . | 10·75 | 15·5 |
| „ pron. . . . . | 5 | 8 |
| „ elytr. . . . . | 25 | 43 |
| „ fem. post. . . | 18 | 30·5 |

*Patria.* Cape Colony (Coll. Brunner, No. 16,698) Slave Coast, Hó (Coll. Brunner, No. 17,437).

This species scarcely differs from *A. lugubris,* m., and I can find no points of distinction other than given above.

17. *Acrida thrymmatoptera,* Karsch.

"Grün, Hinterleibsrücken licht roth, Bauchseite gelb. Auf den

Hinterflügeln einige Queradern dunkel gesäumt. Durch die Deckflügel zieht ein vorn gabliger, dann schmaler und vom Innenrande entfernter, im hinteren Viertel breiter und dem Innenrande sehr nahe verlaufender dunkler Längsstreifen. Oberrand der oberen, Unterrand der unteren Scheidentheile schwarz.

"Scheitel nur wenig länger als der Pronotum-rücken, nach vorn nur ein wenig verschmälert, Scheitelgipfel länger als breit, gleich breit, vorn stumpf, mit gerundeten Winkeln. Fühler sehr breit, wenig schmäler als der Scheitelgipfel. Pronotum-rücken fast gleich breit in seiner ganzen Länge: Basaltheil halb so lang wie der Apicaltheil, flach, nicht ansteigend, auf der Mitte des Hinterrandes spitzwinkelig, die Seitenkiele des Pronotum-rückens ihrer ganzen Länge nach parallel. Krallen mässig lang, Arolium gross, länger als die Krallen. Deckflügel wohl ausgebildet, die Mitte der Hinterschienen ziemlich erreichend. Hinterflügel ausserordentlich kurz, die Mittelschenkel kaum überragend, schmal, am Ende spitz, ♀."

| | ♀ |
|---|---|
| Long. corp. . . . | 92 m.m. |
| „ capitis . . . | 17 |
| „ fastigii . . . | 3·5 |
| „ pronoti . . | 14 |
| „ elytrorum . | 72 |
| „ alarum . . | 18 |
| „ fem. ant. . . | 13 |
| „ fem. med. . . | 14·5 |
| „ fem. post. . . | 45 |

*Acrida thrymmatoptera.* Karsch, 1893, Berl. Ent. Zeit., xxxviii, p. 55, fig. 1, ♀.

*Patria.* W. Africa: Bismarckburg, Nov. 1–Dec. 15, 1890 (*Karsch*).

I only know this species from Karsch's description and figure; its large size and extremely abbreviated wings should distinguish it from the others of the genus. In the shortness of the wings it approaches *Calamus*, Sauss.

### 18. *Acrida variabilis* (Klug.).

Viridis, vel testacea, fusco-variegata. Fastigium verticis haud acute delineatum. Antennæ dimidio basali tantum deplanatæ, dehinc attenuatæ. Pronotum carinis lateralibus antice subrectis, postice divergentibus, postice dilatatum, lobis lateralibus angulo postico recto. Elytra area marginali in parti apicali arearum mediastinæ et scapularis ♂ hyalina, venulis transversis obliquis, regula-

riter dispositis. Alæ hyalinæ, fusco-tesselatæ, interdum flavescentes, præcipue in ♀ basi violaceæ al roseæ. Femora antica pronoti longiora. Ungues tarsorum fortiores, articulo primo breviores, arolio minimo, compresso. Abdomen apice fusco-vittatum. Lamina subgenitalis ♂ breviter acuminata, a latere visa margine postico subtruncato, margine superiori recto. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 44–47 m.m. | 65–74 m.m. |
| „ pron. . . . | 7–8 | 10–14 |
| „ elytr. . . . | 38–42 | 55–61 |
| „ fem. ant. . . | 8·5–9 | 10·5–14 |
| „ fem. post. . . | 25–30 | 36–44 |

*Truxali variabilis.* Klug. 1829, Symb. Phys., tab. xvii, figs. 2–6.
Serv., 1839, Orth., 582.
Burm., 1839, Handb., ii, 607.

*Tryxalis variabilis.* Brullé, 1835, Hist. Nat. Ins., ix, 218.

*Truxalis variabilis.* Burm., 1839, Handb., ii, 607.

*Troxallis variabilis.* Fisch. de W., 1846, Orth. Ross., 232.

*Truxalis obsoleta.* Klug., 1829, Symb. Phys., tab. xvi, fig. 1.

*Truxalis procera.* Klug. ibid., 203.

*Truxalis conspurcata.* Klug., ibid., xvii, fig. 1.

*Truxalis annulatus.* Thunb., 1829, Mem. Ac. Sci. Pet., v, 267.

*Truxalis bilineatus.* Thunb., ibid., 258.

*Truxalis nebulosus*, var. *P.* Thunb., ibid., 267.

*Tryxalis klugii.* Fieb., 1853, Syn. 8 : Lotos., 1854, 177.
Savigny, Descr. de l'Egypte, Orth., pl. v, figs. 6, 8–14.

*Truxalis pharaonis.* Klug., 1829, Symb. Phys., tab. xiv.
Krauss, 1890, Ekl. Sav. Taf., 251.

*Tryxalis* (*Acridella*) *pharaonis.* Bol., 1893, Det. Gen. Tryx., 3 and 4.

*Tryxalis unguiculata.* Fisch., 1853, Orth. Eur., 301, tab. xv, figs. 3, 3a, 4.
Br., 1882, Prod., 90, fig. 21.
Kr., 1886, Orth. Sicil., 10, iv. 1890; Ekl. Orth. Taf. Sav., 28 and 29.
Bonn. and Finn., 1885, Cat. rais. Orth. Tunis., 23.

Bonn., 1886, Orth. Obock., 3.
Borm., 1884, Ann. Mus. Civ. Gen. (2), ii, 102.
Bol., 1889, Ort. Afr. Mus., Lisb., i, 93.
Caz., 1888, An. Soc. Esp., H. N., xvii, 473.
Frey-Gessner., 1872, Mitth. Schweiz. Ent. Ges., xi, 4.
Fieb., 1853, Syn., 8.
Giglio, Tos., 1893, Boll. Mus. Tor., No. 164, p. 5.
Griffini, 1894, Misc. Ent., No. 6, p. 1.
Redt, 1889, Wien., Ent. Zeit., viii, 24.
Schult., 1898, Zool. Jahrb., viii, 73.
Schult., 1898, Ann. Mus. Civ. Gen. (2), xix, 25.

*Truxalis unguiculata.* Ramb., 1838, Faune de l'And., 72.
Finot, 1884, Nom. Cat. Orth. Fr., 6.
Finot, 1897, Orth. Alg. Tun., 411 and 412.
Krauss, 1892, Wien., Ent. Zeit., 148.
Krauss, 1892, Zool. Anzeig., No. 390, 4.
Krauss, 1896, Zool. Jahrb., 560.
Burr, 1900, Linn. Soc. Journ. Zool., 417.

*Acrida unguiculata.* Bol., 1898, Act. Soc. Esp. N. H., 75.
Bol., 1899, Ann. Soc. Ent. Belg., 587.

*Truxalis miniata.* Klug., 1829, Symb. Phys., tab. xviii, figs. 1—4.
Gerst., 1873, Arch. f. Nat., xxv., 215.
Finot, 1897, Orth. Alg. Tun., 411 and 413.
Schult., 1898, Jahrb. Zool., viii, 93.
Serv., 1839, Orth., 583.

*Tryxalis miniata.* Gerst., 1873, Von der Deckens' Reise in Ost.-Afrika, iii, Insecta, 33.

*Tryxalis* (*Acridella*) *unguiculata.* Bol., 1893, Det. Gen. Tryx., 3 and 4.

*Acrida* (*Acridella*) *unguiculata.* Bol., 1898, Ort. Fam. Iber., 43.

? *Gryllus* (*Acrida*) *nasutus.* Linn., 1759, Syst. Nat., ed. x, 427, No. 11.

*Tryxalis* (*Acrida*) *nasutus.* Brullé, 1832, Exp. Moreé., 91.
Krauss, 1877, Orth. vom Senegal., p. 24.

*Acrida nasuta.* Stâl, 1873, Rec. Orth., i, 99.
Bol., 1878, Ort. de Esp., 103, tab. ii, fig. 16.
Dubr., 1878, Ann. Mus. Civ. Gen., xi, 331.
De Borm., 1881, ibid., xvi, 214.

Bol., 1878, An. Soc. Esp., H. N., vii, 461.
Pant., 1886, An. Soc. Esp., H. N., xv, 266.

*Patria.* In EUROPE: the Mediterranean Coast; Andalusia, Sicily, Candia, Corfu (*Bol.*, *Br.*). In AFRICA: Algeria, Egypt (*Finot*), Senegal, Angola, Cape Verd (*Bol.*), Morocco (*Bol.*), Mombassa (*Gerst.*), Somali (*Schult.*). In ASIA: Syria, Jaffa (Coll. m.), Asia Minor, Cyprus, Seir in N.W. Persia (*Burr*), Angora (*Bol.*), Aden (*Schult.*). Var. *variabilis:* Egypt (*Klug.*, *Br.*), Assouan, Khartoum, Nubia. Ladakia, Ceylon; India; Moluccas (Coll. Brunner, Nos. 9102, 9103, 15,694, 15,870, 16,669, 2852, 5038).

Several authors have endeavoured to separate *A. miniata*, Klug. (=*variabilis*, Klug.), *A. pharaonis* and *A. unguiculata*, Ramb., into separate species. Finot (Orth. Alg. Tun.) gives *miniata* and *unguiculata* distinctions in a synoptical table, as well as long descriptions. The only point of distinction which I am able to find consists in the colouring of the wings, especially in the ♂, but this is far too weak a character to suffice. The difference is rather one of degree than of kind, and cannot be made to bear the strain of supporting a species. Finot remarks, however, that although *A. miniata* is found in the same localities as *A. unguiculata*, it reaches the imago stage several months later. For *A. miniata* he gives October, for *A. unguiculata* he gives May to September; larvæ, May to November (in Algeria).

The form *miniata* with crimson wings (♂) occurs in Egypt and Tunis, but has not yet been taken in Europe.

### 19. *Acrida fusco-fasciata* (Bol.).

"Testacea, fusco-fasciata. Fastigium verticis antrorsum distincte angustatum, marginibus plus minusve reflexis; antennæ angustæ. Pronotum dorso pone sulcum posticum elevatum sed parum ampliatum, carinis lateralibus ante sulcum valde flexuoso-angulatis, dein flexuosis sed vix divergentibus, intus fusco-fasciatis, sulco postico ante medium sito; postice acutissime productum; metazona indistincte carinata; lobis deflexis sulco medio profunde impresso, carina interna carinisque marginalibus dorsi antrorsum valde divergentibus. Elytra apice obtuse acuminata, areis mediastina et scapulari in utroque sexu æque dilatatis, opacis, reticulatis; campo discoidali fascia fusca antice pluriundata ornato: furca ulnari longe pone medium sita. Alæ hyalinæ, fascia lata media fusca ornatæ venæ radialis postica pone medium furcata. Pectus haud carinatum;

femora antica pronoto sub-breviora : femora postica elongata, supra apice bispinosa. Ungues articulo tertio parum breviores, arolio parvo. Lamina subgenitalis ♂ brevissima.

| | ♂ | ♀ |
|---|---|---|
| Long. corporis . . . | 33 m.m. | 48 m.m. |
| „ antenn. . . . | 16 | 19 |
| „ pronoti . . . | 6 | 8·5 |
| „ elytrorum . . | 31 | 41 |
| „ fem. ant. . . | 6 | 7·5 |
| „ fem. post. . . | 21 | 29 |

"Semejante al *Tr. serrata*, Thunb., del que á primera vista se distingue por la coloracion de las alas que ofrecen una ancha faja parda dispuesta como en el genera *Pyrgodera*, y ademas por las diferencias siguientes.

"Las antenas son mas estrechas y las quillas laterales del pronoto mas fuertemente sinuosas en su primera mitad y poco mas separadas entre si en la metazona; esta segunda mitad del pronoto aun cuando provista de arrugas longitudinales no aparece tan distintamente estriada como en el *Tr. serrata*, Th. : los lóbulos laterales tienen el borde inferior mas sinuoso y el surco medio profundamente impreso. Los élitros son de igual formas en ambos sexos, con las areas mediastina y escapular completamente reticuladas y opacas ; el campo discoidal ofrece como en el *Tr. serrata*, Th., una faja longitudinal parda, ondeada por delante, pero en la nueva especie las ondas son mucho mas menudas y numerosas. Las alas son de igual forma que en la especie citada y finalmente las patas son delgadas, los fémures posteriores terminan por encima en dos largas espinas y los lóbulos geniculares tambien son espinosos, las uñas del ultimo artejo de los tarsos son apenas mas cortas que este y el arolio es muy pequeño. La placa infra-anal del ♂ es muy corta."

*Tryxalis fusco-fusciata*. Bol., 1890, Ort. Afr. Mus., Lisb., i, 93.

*Tryxalis* (*Acridella*) *fusco-fusciata*. Bol., 1889, Det. Gen. Tryx., 3 and 4.

*Patria*. Quando in ANGOLA (*Bol.*).

Apparently a very distinct species, but I only know it from the description.

## 20. *Acrida serrata* (Thunb.).

Statura minore, robusta : viridis vel testacea, fusco-variegata. Vertex haud acute delineatus. Antennæ capite et pronoto unitis longiores, deplanatae, marginibus integris. Caput breve, fastigium

verticis oculis brevius, haud acute delineatum, lateralibus valde reflexis. Pronotum breve; disci pars antica parte postica multo brevior: pronotum medio constrictum, carinis lateralibus valde flexuosis; margine postico in spinam producto; lobi lateralis carina superiori cum carinis dorsalibus haud parallelæ, angulo postico rotundato-recto. Elytra latiora, maculis albidis seriatim ornata. Alæ hyalinæ, basi flavescentes, apice infumatæ. Valvulæ ovipositoris breves. ♀.

| | ♀ |
|---|---|
| Long. corp. | 43 m.m. |
| ,, antenn. | 19 |
| ,, pron. | 8 |
| ,, elytr. | 39 |
| ,, fem. post. | 27 |

*Truxalis serratus.* Thunb., 1815, Mem. Ac. Pet., v, 269; 1827, Nov. Act. Ups., ix, 84.

*Tryxalis serrata.* Bol., 1889, Ort. Afr. Mus., Lisb., i, 92.
Schult., 1899, Bull. Soc. Vaud. Sc. Nat., xxxv (132), p. 302.
Griffini, 1897, Boll. Mus. Tor., No. 290, p. 5.

*Acrida serrata.* Stål, 1873, Rec. Orth., i, 100.

*Tryxalis* (*Acridella*) *serrata.* Bol., 1893, Det. Gen. Tryx., 3 and 4.

*Truxalis dentatus.* Thunb., 1815, Mém. Ac. Pet., v, 269, iv, 1827; Nov. Act. Ups., ix, 88.

*Truxalis constrictus.* Schaum., 1862, in Peter's Reise Mossamb. Ins., 129, tab. 7, A.F. 1.

*Patria.* ? "India Orientalis" (*Thunb.*); Mozambique (*Schaum*); Huilla and Duque de Bragança in West Africa (*Bol.*). Sierra Leone (Coll. Brunner, No. 1247); S. Africa (*Stål*); Cape of Good Hope (Coll. Brunner, Nos. 2007, 5351, 12,828); Delagoa (*Schult.*); Kazungula on Upper Zambesi (*Griffini*).

A very distinct species, remarkable for the form of the head and pronotum.

### 21. *Acrida somalia*, sp. n.

*A. serratæ*, Thunb., vicina: differt., stature multo majore, fastigio verticis magis acute delineato, antennis marginibus serratis, alæ nigro-tesselatæ læte rubræ, ♀.

| | ♀ |
|---|---|
| Long. corp. . . . . | 60 m.m. |
| „ antenn. . . . . | 20 |
| „ pron. . . . . | 1·5 |
| „ elytr. . . . . | 55 |
| „ fem. post. . . . . | 36 |

*Patria.* Pass Gerator, SOMALI (Coll. Brunner, No. 18,808).

The only specimen, a female, was captured by Ketter, Pass Gerator, Somaliland, and was obtained from Dr. Schultess-Rechberg, who, however, in his paper on Orthoptera collected there by Dr. C. Ketter, makes no reference to it.

### 22. *Achurum*, Sauss.

Statura gracili. Caput elongatum, lateribus parallelis, horizontale: vertex rotundatus, convexus, medio carinatus, lateribus reflexis: frons, a latere visa, sinuata: foveolæ laterales lineares. Antennæ deplanatæ, triquetræ, acuminatæ, capite et pronoto unitis oreviores. Pronotum supra deplanatum, carinis rectis, parallelis, sulco typico pone medium interruptis, margine antico recto, postico rotundato: lobi laterales margine antico obliquo, inferiori recto, postico sinuato. Prosternum spina parva armatum. Elytra angusta, apice acuminata. Alæ perfecti explicatæ. Femora postica valde compressa, lobis genicularibus in spinas obtusas productis. Valvulæ ovipositoris breves. Tibiæ posticæ margine externo spinulis circ. 17 armatæ, calcaribus terminalibus haud valde inæqualibus.

*Achurum.* Sauss., 1861, Orth. Nor. Am., ii, 15.
Stål, 1873, Rec. Orth., ii, 9.
Brunner, 1893, Rev. Syst. Orth., 118.
MacNeill, 1897, Rev. Trux. N. Am., 201.

*Typus generis Achurum sumichrasti.* Sauss.

*Dispositio specierum.*

1. Elytra abdomen valde superantia: pronotum alutaceo-rugosum . . . . . 1. *Sumichrasti*, Sauss.
1.1. Elytra abdomen haud superantia: pronotum haud alutaceo-rugosum . . . 2. *Acridodes*, Stål.

### 23. *Achurum sumichrasti*, Sauss.

Statura minore. Viridæ vel testaceam. Gracilis, compressum. Caput breve. Pronotum alutaceo-granosum, medio carinatum, ante

medium sulco incompleto interrupto, pone medium sulco typico instructum ; carinæ lateralis parallelæ : margo anticus rectus, postico rotundatus : lobi lateralis margine antico obliquo, infero recto, postico sinuato, angulo postico acuto. Elytra perfecte explicata, femora postica et abdominis apicem valde superantia, angusta, apice acuminata. Alæ angustæ, elytris breviores, hyalinæ, leviter infumatæ, campo antico excepto, margine antico in tertia parti parte apicali macula angusta testacea ornato. Pedes breves, gracilis. Femora postica valde compressa, elytris et abdomine valde breviora. Lamina supraanalis ♀ conica, obtusa, valvulæ ovipositoris breves. ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 38 m.m. (after Sauss.). |
| „ elytr. . . . | 34 |
| „ fem. post. . | 15·5 |

*Truxalis* (*Achurum*) *sumichrasti*. Sauss., 1861, Orth. Nor. Amer. Diagn. Prélim., Series ii*a*, p. 15; Rev. Mag. Zool., 313.
Thos., 1873, Acrid. N. Am., 195.

*Achurum sumichrasti*. Gerst., 1861, Arch. f. Nat., xviii, ii, 317; iv, 1851, Bericht., 45 (teste Scudd.).
Scudd., 1868, Cat. Orth. N. Am., 83.
Walk., 1870, Cat. Derm. Salt, iii, 518.
Stål, 1873, Rec. Orth., i, 101.
MacNeill, 1897, Rev. Trux. N. Am., 202, fig. 2, *a* and *c*.
Scudd., 1900, Cat. Descr. Orth. U.S. and Canada, 19.

*Patria*. "Mexico Temperata" (*Sauss.*); Mexico (Coll. Brunner, No. 6806); Guatemala (Coll. Brunner, No. 6986); Arizona (*Scudd.*); Fort Grant in Arizona (U.S. Nat. Mus., *McNeill*).

### 24. *Achurum acridodes* (Stål).

"Fusco testaceum ; vertici, dorso pronoti areaque anali elytrorum virescentibus ; genis lobisque lateralibus pronoti dorsum versus obtusoribus : elytris griseo-hyalinis, area anali excepta, fuscovenosis : alis infuscatis.

"Forti ad *A. sumichrasti*, Sauss., referendum, colore dorsi pronotoque dorso haud alutaceo-rugoso, sed antice et in lobo postico obsolete punctulato, lobisque lateralibus obsolete variolosi differre videtur. Elytra corpore paullo breviora, femoribus posticis plus longiora, venis anali et axillari libere excurrentibus. Femora postica apicem abdominis haud attingentia. Lobi metasterni pone impressiones toti contigui. Antennæ vertice paullo angustiores, capite et

pronoto simul sumtis nonnihil longiores. Segmentum genitale maris longum, productum, sensim acuminatum. ♂ Long. 27 m.m."

*Truxalis acridodes.* Stâl, 1873, O. N. A. F., 30, ii, p. 52.

*Achurum acridodes.* Stâl, 1873, Rev. Orth., i. 101.
McNeill, 1897, Rev. Trux. N. Am., 202.

*Patria.* Mexico (Mus. Holm.; *Stâl*).

I only know this species from Stâl's description; it is also unknown to McNeill. It may not be distinct from *A sumichrasti.*

### 25. *Gelastorrhinus,* Brunner.

Caput elongatum, vertex brevis, lineola curvata inter oculos delineatus. Antennæ longæ, ensiformes, ab oculis parum remotæ. Frons valde reclinata, costa sulcata, carinis parum divergentibus, carinis lateralibus rectis. Pronotum supra planum, tricarinatum. Elytra et alæ acuminatæ. Prosternum dente minimo vix distinguendo armatum. Femora intermedia coxas posticas superantia. Femora postica gracilia, supra carinata, apice in lobos duos, acutos, plus minus longos, producta. Tibiæ posticæ extus spinis 13–20 armatæ, supra spina-apicali externa nulla. Abdomen compressum. Lamina supra-analis ♂ acuminata, sulcata. Cerci utriusque sexus depressi, apice acuminati vel rotundati. Valvulæ genitales ♂ superiores inermes, inferiores leviter denticulatæ. ♂ ♀.

*Gelastorhinus.** Brunner, 1893, Révision, p. 157.
Sauss., 1899, Senck. Nat. Ges., xxi, 633.

*Dispositio specierum.*

1. Rostrum a vertice sulco ita ∧ disjunctum. Antennæ capite et pronoto unitis æque longæ. (Tibiæ posticæ femoribus post æque longæ. Elytra albolineata) . . 1. *Edax*, Sauss.

1.1. Rostrum a vertice sulco parabolico ita ⌒ disjunctum. Antennæ capiti et pronoto unitis longiores.

2. Statura majore, robusta. Tibiæ posticæ femoribus posticis æque longæ.

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* The name was invented by de Saussure, from γέλαστος, *ridiculus*, and ῥίς—*nasus*, but in combination ῥ must be doubled.

3. Elytra albolineata. Tibiæ posticæ extus spinis 15–20 armatæ . . . [Brunner.
2. *Albolineatus*,

3.3. Elytra viridia, haud albolineata. Tibiæ posticæ extus spinis 12–15 armatæ . . . . . 3. *Selache*, sp. n.

2.2. Statura minore gracili. Tibiæ posticæ femoribus (præcipue in ♀) breviores.

3. Area discoidalis elytrorum vena intercalata una instructa, venulis transversis sat distantibus. Species javanica . . . . . 4. *Lucius*, sp. n.

3.3. Area discoidalis elytrorum venis intercalatis falsis pluribus instructa, venulis transversis conferti reticulata. Species japonica . . . . 5. *Esox*, sp. n.

## 26. *Gelastorrhimus edax*, Sauss.

Statura minore. Testaceus, viridi-variegatus. Antennæ capite et pronoto unitis æque longæ, dimidio basali deplanatæ, parti apicali attenuatæ. Frons a latere visa sinuata. Pronotum supra deplanatum, a latere visum, subconcavum ; carinæ laterales levissime sinuatæ, fere rectæ et parallelæ ; sulcus typicus pone medium situs ; margo anticus rectus, posticus subrotundatus : lobi laterales margine antico inclinato recto, inferiore recto, postico sinuato. Elytra angusta, hyalina, testacea, area mediastina vitta humerali albida, intus vittâ angustâ nigro- marginatâ ornata ; elytra abdomen et femora postica superantia. Alæ elytris breviores angustæ, acuminatæ, hyalinæ. Femora postica lobis genicularibus acuminatis. Tibiæ posticæ spinulis extus 17 inter 15 armatæ. ♂ ♀.

| | ♀ |
|---|---|
| Long. corp. . . . . | 40 m.m. |
| „ pron. . . . . | 7·5 |
| „ elytr. . . . . | 32 |
| „ fem. post. . . . | 21 |

*Gelastorhinus edax*. Sauss., 1899, Abh. Senck. Naturf. Ges., xxi, 634, figs. 31, 32.

*Patria.* Madagascar ; Majunga and Makambi Island in Boeni Bay (Sauss.) ; Nossi bé (Coll. Brunner, No. 14,942) ; Madagascar (Coll. Brunner, Nos. 17,925, 19,340) ; Ceylon (Coll. Brunner, Nos. 15,871, 16,256).

De Saussure says : "*Pronotum unicolor.*" The lateral lobes are however usually green, and this general colour varies.

### 27. *Gelastorrhinus albolineatus*, Brunner.

Statura majore. Colore pallido fulvo-testaceo. Fastigium verticis oculo brevius, acutum, sulco parabolico a vertice disjunctum. Antennæ parum supra oculos insertæ, ensiformes, capite et pronoto unitis æque longæ. Frons, a latere visa, levissime sinuata. Pronotum supra planiusculum, tricarinatum, fulvo-testaceum, utrinque vitta longitudinali fusciori signatum, lobis deflexis pallide viridibus. Elytra apicem abdominis superantia, fulvo-testacea, versus venam radialem sensim fusciora, hac vena basi atra, vitta longitudinali eburnea, albida apposita. Femora postica supra acute carinata, apice in lobos duos sat longos producta. Tibiæ posticæ extus spinio 15–20, apice nigris, armatæ ♀.

| | ♀ |
|---|---|
| Long. corp. . . . | 54 m.m. |
| „ pron. . . . | 9 |
| „ elytr. . . . | 41 |
| „ fem. post. . | 30 |

*Gelastorhinus albolineatus.* Brunner, 1893, Rév. Syst. Orth., 158.

*Patria.* Bhamo in Burmah (*Brunner*).

### 28. *Gelastorrhinus selache*, sp. n.

Statura majore robusta. Colore viridi, rubro-variegato. Rostrum a vertice sulco parabolico disjunctum. Oculi rubri: vitta rubra ab oculis per genas, carinasque laterales pronoti in venam radialem parte proximali elytri producta. Antennæ longæ, capite et pronoto unitis valde longiores. Pronotum deplanatum: lobi laterales marginibus antico et postico obliquis, sinuatis, inferiori subrecto. Elytra latiora, magna, longa, vitrina, vena radiali in parte basali rubrescente. Alæ elytris breviores, vitrinæ, basi leviter fulvo-inflatæ. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 47 m.m. | 60 m.m. |
| „ antenn. . . . . | 24 | 21 |
| „ pron. . . . . | 8 | 12 |
| „ elytr. . . . . | 34 | 54 |
| „ post. . . . . | 20 | 26 |

*Patria.* Sikkim (Coll. Brunner, No. 22,847).

### 29. *Gelastorrhinus lucius*, sp. n.

Rubro-testaceus viridi, variegatis. Statura gracillimi. Antennæ longæ, capite et pronoto unitis longiores. Rostrum a vertice sulco parabolico disjunctum. Pronotum deplanatum, carinis parallelis,

sulco typico pone medium sito ; margine antico recto, postico rotundato. Elytra angusta, longissima, femora postica et abdomen valde superantia, rubro-testacea, parte anteriori viridi. Alæ angustæ, hyalinæ, levissime infuscatæ, costa anteriori necnon ornata. Femora postica basi incrassata, abdomine breviori.

A. *G. esoci* vix distinguendus : differt statura graciliori, elytris longioribus.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 26 m.m. | 42 m.m. |
| „ antenn. . . . . | 17 | 16 |
| „ pron. . . . . | 4 | 7 |
| „ elytr. . . . . | 26 | 39 |
| „ fem. post. . . . | 12 | 15·5 |

*Patria.* West Java (Coll. Brunner, No. 19,391).

*Gelastorrhinus esox,* sp. n.

Ab *E. edaci* tantum differt, vertice a rostro sulco parabolico disjunctus (⌒), elytris haud albolineatis. Antennæ capite et pronoto unitis valde longiores. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . . | 25 m.m. | 44 m.m. |
| „ pron. . . . . | 4 | 7·5 |
| „ elytr. . . . . | 25 | 41 |
| „ fem. post. . . . | 12 | 17 |

*Patria.* Japan (Coll. Brunner, Nos. 5740, 6562, 12,067).

30. *Hyalopteryx exaggeratus,* sp. n.

Statura mediocri. Valde compressus, testaceus. Elytra lanceolata, apice acuminata, margine antico curvato, postico obtusangulo : venæ ut in *H. rufipenni* : alæ ♂ area fenestrata venis transversis 8 instructa : campus analis citrinus. Femora postica calcari terminali interiori quam exteriori multo majore. ♂.

| | ♂ |
|---|---|
| Long. corp. . . . . | 31 m.m. |
| „ antenn. . . . . | 9·5 |
| „ pron. . . . . | 5 |
| „ elytr. . . . . | 29 |
| Lat. „ max. . . . | 7 |
| Lat. „ area fem. . . | 5·5 |
| Long. fem. post. . . . | 16 |

*Patria.* Chiquitos (Coll. Brunner, No. 23,027); Bolivia (Coll. mea.).

In venation and structure, this form resembles *H. rufipennis*. It is however even more compressed, lighter in colour, and the wings are clear yellow.

### 31. *Calamus*, Sauss.

Linearis, elongatus, gracilis. Caput valde elongatum, subspiniforme, horizontale productum ; rostrum ita formatum, apice truncatum, supra concavum, striatum. Oculi haud prominuli, longe pone medium capitis inserti. Antennæ ensiformes, deplanatæ. Pronotum capite haud latius, parallelum, striatum, antice et postice truncatum, tertiam partem longitudinis capitis æquans. Prosternum tuberculo parvo instructum. Elytra angustissima valde elongata, apice acuminata. Alæ breviores, ♂ plus minus coloratæ, ♀ hyalinæ ; ♂ abdominis longitudine, ♀ abdominis dimidio breviores. Abdomen lineare, supra carinatum. Pedes graciles, breves ; femora postica capite haud longiora, lobis genicularibus brevibus, acutis,* genubus supra in spinam longam productis. Tibiæ posticæ femora breviores. Lamina subgenitalis ♂ cuculluta, subtus pilosa, valde elongata, acuminata.

*Calamus.* Sauss., 1861, Ann. Soc. Ent. Fr. (4), i, 476, Karsch. 1893, Berl. Ent. Zeit., xxxviii, p. 56, fig. 3.

In spite of the presence of a small prosternal tubercle, this genus in every other way belongs here. The only specimen in the Brunner collection was arranged among the *Mesopes*. I have no hesitation in following Karsch and ranging it with the *Amyci*.

### 32. *Calamus linearis*, Sauss.

Fusco-testaceus. Elytra immaculata, testacea, apice pallidiora. Alæ ♂ abdominis longitudine, hyalinæ, leviter fusco-tesselatæ, vel fere totæ fuscæ, leviter pallido-punctatæ ; ♀ abdominis dimidio breviores, hyalinæ, incolores. ♂ ♀.

| | ♂ | ♀ |
|---|---|---|
| Long. corp. . . . | 30 m.m. | 47 m.m. |
| „ capitis. . . | 9 | 14·5 |
| „ pron. . . . | 3·5 | 5 |
| „ elytr. . . . | 32 | 42 |
| „ alarum. . . | 14 | 14 |
| „ fem. post . . | 12·5 | 17 |

* It should be noticed that it is not the *lateral* genicular lobes, but the superior one, that is produced into a spine.

*Calamus linearis.* Sauss., 1861, Ann. Soc. Ent. Fr. (4), p. 476, pl. ii, fig. 3.
Karsch, 1893, Ins. von Adeli, 56, fig. 3 (excl. syn. Bol.).
Griffini, 1897, Boll. Mus. Tor., No. 290, p. 6 (excl. syn.).

(?) *Mesops gracilis.* Burm., 1839, Handb. ii, 610.

*Patria.* ? (*Sauss.*); Bismarckburg (*Karsch*); Bogos (Coll. Brunner, No. 12,768); Kazungula on the Upper Zambesi (*Griffini*); Hó on the Slave Coast (Coll. Brunner, No. 17,436).

Bolivar (Ort. Afr. Mus., Lisb., i, 1889, p. 94) wrongly regards this species as synonymous with *Amycus xanthopterus*, as Karsch rightly points out, and he misquotes Bolivar's *rhodiopterus;* but I fail to see why the latter assumes that Bolivar's species should be *C. linearis*, and that his determination is wrong. I prefer to merely regard Bolivar's synonymy as faulty.

De Saussure's figure is incorrect in omitting the prominent genicular spines, and Karsch's drawing shows the position of the eyes inaccurately. Griffini considers Karsch's insect as an entirely different species, but it appears to me that it entirely agrees with *C. linearis*, Sauss.; the Italian author bases his opinion on Karsch's drawing, especially on the position of the eyes; the specimen in the Brunner collection agrees equally well with the *C. linearis* of de Saussure and of Karsch. I prefer to disagree with Griffini, in regarding Karsch's determination as correct.

## 33. *Amycus*, Stål.

Statura minori. Caput pronoto haud longius, antice rotundatum. Antennæ breves, basi deplanatæ, apice cylindricæ, segmento apicale composito. Caput et pronotum supra tota rugis longitudinalibus instructa. Pronotum compressum, margine antico truncato, postico acutangulo: lobi laterales margine antico obliquo, infero recto, postico sinuato. Elytra angusta; alæ elytris breviores. Pedes breves; femora postica abdomen paullo superantia, elytrorum apicem haud attingentia, lobis genicularibus lateralibus acuminatis, superioribus in lobos obtusos productis. Tibiæ posticæ spinis parvis 8 armatis.

*Amycus.* Stål, 1855, Ö. V. A. F., 353.
Stål, B., 1873: Rec. Orth., i, 89.

Karsch, 1893, Orth. Adeli, 59.
Brunner, 1893, Rév. Orth., 118.
*Typus generis.* *Amycus xanthopterus*, Stål.

*Dispositio specierum.*

1. Antennæ margine externo serratæ. Alæ coloratæ.
1. *Xanthopterus*, Stål.
1.1. Antennæ margine externo integræ. Alæ vitrinæ.
2. *Achromopterus*, Karsch.

### 34. *Amycus xanthopterus*, Stål.

Fusco-testaceus, necnon pallido-variegatus ; elytris apice, genubusque infuscatis. Alæ hyalinæ, aurantiaco- vel roseo-inflatæ : antennæ parte basali segmentis deplanatis, margine externo angulo apicali in dentem productis, segmentis apicalibus cylindricis.

♀

| | |
|---|---|
| Long. corp. . . . . | 26 m.m. |
| „ antenn. . . . . | 4·5 |
| „ pron. . . . . | 4·75 |
| „ elytr. . . . . | 21 |
| „ fem. post. . . . | 14 |

*Amycus xanthopterus.* Stål, 1855, Ö. V. A. F., 353; ibid., 1873; Rec. Orth., i, 100.
Bol., 1889, Orth. Afr. Mus., Lisb., i, 94 (excl. syn.).

*Amycus rhodiopterus.* Stål, 1855, Ö. V. A. F., 353; ibid., 1892, Rec. Orth., i, 100.
Karsch, 1893, Orth. von Adeli, 59.

*Patria.* Caffraria (*Stål*); Duque du Bragança, Caconda and Cabinda in Angola (*Bol.*); Bismarckburg (*Karsch*); Port Natal (Mus. Berl. teste Karsch, l. c.); Natal (Coll. Brunner, Nos. 2305 and 6739), Weener in Natal (Coll. mea.).

I have little hesitation in uniting the two forms, with yellow and red wings respectively, into one species, as has been suggested by Karsch. I do not agree however with the latter in regarding *Machæridia tæniata*, Bol., as synonymous, owing to its "*elytra viridia*."

### 35. *Amycus achromopterus*, Karsch.

Fusco-testaceus, lobis lateralibus pronoti, sternis, pleuris, abdomine pallidis, femoribus posticis apice excepto pallidis, nigro-punctulatis, alis vitrinis, margine antico fusco necnon parte dimidia apicali infuscata. ♂.

| | ♂ |
|---|---|
| Long. corp. . . . | 20·5 m.m. |
| „ pron. . . . | 3·8 |
| „ elytr. . . . | 15·5 |
| „ fem. post. . | 11·4 |

*Amycus achromopterus.* Karsch, 1896, Stett. Ent. Zeit., 250.

*Patria.* East Africa: Nyassa, Milanji (*Karsch*).

The antennæ are more slender than in the preceding species, and also longer; the depressed basal part is not serrated on the outer margin. The wings are plain and not coloured.

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Note.—Since the above went to the press, I have seen Mr. Kirby's work on a "Collection of Locustidæ, formed by Mr. W. L. Distant in the Transvaal" (ante, p. 57), which will necessitate the modification of some points in this paper. The *Acrida turrita* of Mr. Kirby coincides with my *Acrida nasuta*, whereas his *Tryxalis nasuta* coincides with my *Acrida variabilis;* his *Acrida gigantea*, Fuessly, is the striped form of my *Acrida nasuta*. I have inadvertently omitted *Acrida madecassa*, Brancsik (1893, Jahresb. Ver. Trencsen, xv, p. 186, from Madagascar), which appears to me to differ little, if at all, from *Acrida nasuta*, Linn. The two species *Acrida rendalli*, Kirby, and *Acrida aspersata*, Kirby, do not clash with any described by me.

# XI. Notes on some cases of Seasonal Dimorphism in Butterflies, with an account of Experiments by Mr. G. A. K. Marshall, F.Z.S. By Frederick A. Dixey, M.A., M.D., F.E.S., Fellow of Wadham College, Oxford.

[Read March 19th, 1902.]

Plate IV.

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## 1. Seasonal Dimorphism in *Catopsilia pomona*, Fabr.

I have long been of opinion, from the examination of many hundred specimens, that no line of specific demarcation can be drawn between *Catopsilia pomona*, Fabr., and *C. crocale*, Cram. This conclusion was based mainly on the fact that, distinct in appearance as typical examples of the two forms undoubtedly are, it is easy to arrange a series of examples showing every possible gradation between the two. The relation between *C. pomona* and *C. crocale* so much resembles that between forms which there is reason for regarding as cases of seasonal dimorphism, that I was led to suspect that the dimorphism of *C. pomona-crocale* might also have a seasonal significance. In 1898 I mentioned my suspicion to Mr. Trimen, showing to him at the same time a good series, including many transitional forms, of *C. pomona*, which had been captured near Brisbane in 1897 by T. Batchelor, and presented to the Hope collection by Mr. G. C. Griffiths. This series was noticed by Mr. Trimen in his Presidential Address to the Entomological Society of London, delivered on January 18, 1899, and was considered by him as "lending some probability to the view

that *C. crocale* and *C. pomona* (including *C. catilla*) will prove to be seasonal forms of one species." * Direct evidence on the point was, however, lacking; and I therefore welcomed a statement made later by Batchelor in a letter from Brisbane, and kindly communicated to me by Professor Poulton, that *C. crocale* and *C. pomona* were one species, "*crocale* being the summer brood and *pomona* the autumn one." It does not appear that any observer has as yet actually bred one form from the other, so that it cannot even now be said that their specific identity is proved with absolute certainty. Nevertheless, the opinion of a collector who has taken large numbers of both forms is of weight, and may safely be held to indicate a strong probability that, at all events in part of their range, *C. pomona*, Fabr. and *C. crocale*, Cram. are seasonal phases of the same species.

It is, however, evident that the case with regard to *C. pomona* is not quite a simple one. In the autumn of 1900, a series of eighteen specimens of *Catopsilia* was received by the Hope Professor at Oxford from the late Mr. L. de Nicéville, who stated that they were all caught nearly at the same time in the Kangra Valley, Western Himalayas, by Mr. G. C. Dudgeon. Of these eighteen, sixteen were taken on August 11, and the remaining two on August 13, 1900. Two of the captures on August 11 were *Catopsilia pyranthe*, Linn.; and of the remainder, eight were *C. crocale*, Cram., and six were *C. pomona*, Fabr. Those caught on August 13 were *C. crocale* ♂ and *C. pomona* ♀ taken in copulâ. In two private letters to the Hope Professor, Mr. de Nicéville appeals to this series of specimens in support of the view that *C. pomona* † and *C. crocale* constitute one

* Proc. Ent. Soc. Lond., 1898, p. lxxvi. It is hardly necessary to recall the fact that this address of Mr. Trimen's contains an excellent account of nearly all the experiments and observations that had been made on the subject of seasonal dimorphism in butterflies up to the time of its delivery.

† De Nicéville calls it *C. catilla*, Cram.; but the latter name, under which Cramer figures the form with brownish-crimson patches on the under-surface (*see* Cramer, Pap. Exot., III. t. 229, D, E), is later than that of Fabricius. Fabricius's type still exists in the Banksian cabinet, where I have examined it in concert with Dr. A. G. Butler. The six specimens of *C. pomona* caught on August 11 include two *C. catilla*, Cram. The British Museum contains six specimens of *C. crocale* and seven of *C. pomona* caught by Mr.

variable species, the variation not being due to seasonal causes. This view was published by de Nicéville in 1894, and was reiterated by him on several subsequent occasions.* There can be no doubt that de Nicéville's opinion receives support from the present series of specimens. The fact of *C. crocale* ♂ pairing with *C. pomona* ♀ tends to show their specific identity, while the simultaneous occurrence of the two forms in presumably equal numbers seems adverse to the supposition that the dimorphism of this species has a seasonal significance.

With regard to the first point, that of specific identity, I think there can now be no reasonable doubt that the case is made out. I have already mentioned my own conviction on the matter, which was arrived at independently, and on different grounds. Batchelor's observations here coincide with de Nicéville's; and it may be added that Piepers,† who has bred the species in large numbers, is strongly of the same opinion. On the other hand, Dr. L. Martin, writing of the butterflies of Sumatra (Journ. Asiat. Soc. of Bengal, LXIV, ii, p. 490, 1895), considers *C. crocale* and *C. catilla* (*pomona*) distinct, on the following grounds:—*C. crocale*, the far commoner form, occurs on roads, near houses and gardens, and is never found in the forest. *C. catilla* is found only in the forest. The antennæ of *C. crocale* are black in both sexes, those of *C. catilla* are red. The underside of the males in *C. crocale* is unspotted, and the tuft of hair on the inner margin is whitish. In *C. catilla* the males, like the females, have reddish spots on the underside of both wings, and the tuft of hair is

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Dudgeon on the same occasion (August 12) as those mentioned above. They are stated to have formed part of a migratory flight which lasted all day.

* Gazetteer of Sikkim, p. 166, 1894; Journ. Asiat. Soc. Bengal, LXIV, ii, p. 490, 1895; Journ. Bombay Nat. Hist. Soc., xi, p. 586, 1898; Journ. Asiat. Soc. Bengal, LXVIII, ii, p. 211, 1899. The first two of these are cited by Mr. Trimen, *loc. cit.*, p. lxxvi, note.

† "Die Farbenevolution bei den Pieriden," Tijdschr. der Nederlandsche Dierk. Vereenig.; (2) Deel V, p. 119, 1898. Piepers gives *thauruma*, Reak., as a synonym; the latter, however (from Madagascar), is unquestionably distinct. "*Pomona*, Cram." (*ibid.*) is a slip; the name was bestowed by Fabricius. Piepers's view was first published in 1891—"Observations sur des vols de Lépidoptères"—Natuurkundig Tijdschrift voor Ned.-Indië, Dl. L, 1891, pp. 205, 222. In the same periodical, Dl. LVII, 1898, he repeats it, but speaks, rather curiously, of "*Gnoma*, Feld.," as a form of "*Catopsilia pomona*, Cram." (*loc. cit.*, p. 111).

distinctly yellow. The females of both forms are variable, but the range of variation is distinct in the two. De Nicéville, however, rightly remarks that "the distinctive characters on which Dr. Martin relies are all quite inconstant, and entirely break down" when large numbers of both forms are examined. It may be added that the difference of habit alleged to exist between *C. crocale* and *C. pomona* is no disproof of specific identity, inasmuch as a similar difference, witnessed to by both Trimen * and Marshall,† obtains between *Precis sesamus*, Trim. and the southern representation of *P. octavia*, Cram. (called by Marshall *P. octavia-natalensis*). The form *natalensis*, according to Marshall, frequents high, open spots; *sesamus* is shade-loving, though it occasionally flies with *natalensis*, especially at the change of seasons. *Sesamus* is more wary than *natalensis;* it is more often found in gardens, and occasionally enters human habitations. It also contrasts with *natalensis* in being at times gregarious. But in spite of these well-marked divergencies of habit, the two forms, as is well known, have been absolutely proved to be seasonal phases of the same species. Hence, in the case of *C. pomona* and *C. crocale*, Dr. Martin's objection on the score of habit cannot be held any more conclusive than that founded on the difference in aspect.

With regard to the second point, that of the seasonal relations of the two forms, it seems that the utmost we can at present allege is that in part, at all events, of its range the dimorphism of *C. pomona* is associated with the change of season. That this is not the case everywhere is evident from de Nicéville's observation, as quoted by Trimen,‡ that "the innumerable varieties which are found in both sexes occur at all times;" and, more particularly, from the statement that "both true *C. crocale* and the dimorphic form, *C. catilla*, Cram. occur commonly in Mussoorie from July to October, and in Dehra Dun throughout the warmer months of the year." § On the other hand, we have Batchelor's categorical assertion from

* South-African Butterflies, vol. I, 1887, pp. 230, 233.

† Ann. Mag. Nat. Hist., 1898, vol. II, pp. 33, 34.

‡ Proc. Ent. Soc. Lond., 1898, p. lxxvi.

§ Mackinnon and de Nicéville, Journal of Bombay Nat. Hist. Soc., vol. XI, 1898, p. 586. Piepers also denies absolutely that the dimorphism of *C. pomona* is seasonal ("Notes from the Leyden Museum," vol. XXII, 1899, note 1, p. 13, *ibique cit.*).

Brisbane, given above; while the fact recorded by Dr. Martin (*loc. cit.*) that among many hundreds of both sexes of *C. crocale*, all presumably belonging to one emergence, taken by him near Bindjei, there was not a single *C. catilla* (*pomona*), may possibly have a similar significance.*

It is not a little remarkable that although there are forty-three specimens of *C. pomona* and *C. crocale* in the Hope collection duly labelled with locality and date, they cannot be said to throw much light on the question of seasonal dimorphism. What is wanted is a long series of observations carefully carried on in one locality, and accompanied, if possible, by breeding experiments.

If, as is probable, it should eventually be shown beyond doubt that the different forms of *C. pomona*, though related to the seasons in some part of its range, occur indifferently at all times in others, the case would by no means stand alone. I propose in the next place to notice very briefly several statements that have been made by different authorities with regard to other species, which statements tend to show that in many cases where the existence of seasonal modification has been reasonably presumed, or even actually demonstrated, the seasonal relation is far from being rigidly fixed in all parts of the area of distribution.

## 2. Seasonal Dimorphism in *Catopsilia pyranthe*, Linn.

The first instance that may be taken is that of *Catopsilia pyranthe*, Linn. This butterfly grades imperceptibly into *C. gnoma*, Fabr. just as *C. crocale* does into *C. pomona*. Here again, in the absence of breeding experiments, the absolute proof of specific identity is still lacking; but de Nicéville had no doubt, from his own observations, that the two forms represent a single species. In this case he is able to assign a seasonal value to the two forms,—*C. pyranthe* being in his opinion the wet-season, and *C. gnoma* the dry-season phase of the species. But the point of special interest, in view of the irregularity that appears to obtain in the seasonal relations of *C. crocale* and *C. pomona*,

* It should, however, be noted that "N.-E. Sumatra does not possess a well-marked dry and wet season, such as is found over most of the continent of India, there being no month in the year when it does not rain." Journ. Asiat. Soc. Bengal, LXIV, 1895, pt. ii, p. 362. See below, p. 196.

is the fact that, as recorded by de Nicéville himself, the different forms of *C. pyranthe*, though corresponding to the seasons in some parts of its range, are independent of them in others. Thus, in speaking of this species under the name of *C. chryseis*, Drury, he notes that "it is not seasonally dimorphic in Sumatra as it is in India." * Again, he remarks under *C. pyranthe*, "Moore in the 'Lepidoptera of Ceylon' gives four forms of this species as separate species; *C. gnoma*, Fabr., *C. ilea*, Fabr., *C. chryseis*, Drury, as well as typical *C. pyranthe*. Manders notes that as far as his observations go these four forms are not dependent on season, but appear indiscriminately nearly throughout the year, those flying in the dry season from February to April being a little smaller than those found during the rest of the year." † On the other hand he says, "True *C. pyranthe* is not very common in Mussoorie in the rains; the dry-season form, *C. gnoma*, Fabricius, even less so. In the Dun both forms are common in their respective seasons." ‡

If then we are to trust the observations that have been cited, we are led to the conclusion that in these *Catopsilias*, viz., *C. pomona* and *C. pyranthe*, we have to deal with two polymorphic species, each of which has no doubt several geographical forms, and each of which shows, in most localities, a special tendency to cleavage into two well-contrasted types. These latter phases in each case are in some parts of the range of the species dependent on seasonal changes; in other parts, however, they show no such connection.

We may now pass on to the consideration of similar irregularities as shown in other groups.

### 3. Irregularities of Seasonal Dimorphism in various Genera.

It has been recorded by most of those who have experimented on the subject, that there are individual differences in the reaction of members of the same brood to what appear to be identical conditions of the environment. A conspicuous instance of this is the well-known

* Journ. Asiat. Soc. Beng., LXIV, 1895, ii, p. 490.
† *Ibid.*, LXVIII, 1899, ii, p. 211.
‡ Journ. Bombay Nat. Hist. Soc., XI, 1898, p. 586.

experience of Mr. Marshall, who in April 1898 bred a specimen of *Precis sesamus* and another of *P. octavia-natalensis* from two eggs, laid on the same day by the same mother, and reared under precisely similar conditions.* Dr. Butler has also put it on record that Captain Nurse bred *Teracolus yerburii*, Swinh., and *T. nouna*, Luc.,† from a batch of similar larvæ, the perfect insects presumably emerging at the same season. Many cases have been observed where, although each of the two forms of a species is on the whole confined to its own time of year, there is yet a considerable amount of overlapping at the change of seasons; this overlapping showing itself both by the simultaneous occurrence of freshly-emerged specimens of both phases, and also by the appearance of a more or less complete series of "intermediates." A good instance of the simultaneous occurrence, in the field, of different phases believed on strong grounds to be seasonal, is afforded by the capture of all three forms ("wet," "dry," and "intermediate") of *Precis sesamus* by Mr. Crawshay at Nairobi within little more than a week during the month of April.‡ Many records of this kind are in existence; and are often, no doubt, to be ranked as examples of the seasonal overlapping that has just been mentioned.

It is however evident that there are numerous cases of simultaneous occurrence which cannot be brought under this head. Besides the definite statements of de Nicéville with regard to two species of *Catopsilia*, we have now a considerable bulk of evidence, with regard to many species, of the appearance side-by-side, at all times of year, of forms closely analogous with what are now well established as seasonal phases. Thus, again according to de Nicéville, the ocellated and non-ocellated forms of *Melanitis leda*, Linn., which he has shown to be related in India to the wet and dry seasons respectively, both occur in North-East Sumatra all the year round. In Java it has been

* Ann. Mag. Nat. Hist., 1898, vol. ii, p. 30.

† More accurately, perhaps, *T. evagore*, Klug. *T. nouna* is the dry-season phase of the African form *T. daira*, Klug. Capt. Nurse's larvæ were found at Shaik Othman, and no doubt belonged to the Arabian form, of which *T. yerburii*, Swinh., is the wet, and *T. evagore*, Klug, the dry-season phase. This is pointed out by Butler in Ann. Mag. Nat. Hist., 1897, vol. ii, p. 460. The original record is in Proc. Zool. Soc., 1896, p. 247.

‡ Proc. Zool. Soc., 1900, p. 916.

noted by Piepers * that the non-ocellated form, though on the whole belonging chiefly to the dry season, is also to be met with during the rains. It is true, as Piepers says, that in Java, as in the Malayan Islands generally, the distinction between dry and wet season is not so sharp as on the Indian mainland; so that a certain amount of intermingling of the two forms might perhaps have been antecedently expected. It does not appear, however, that all dimorphic species are affected by these or the like conditions in the same way. De Nicéville points out, in a passage quoted by Trimen, that with this exception of *Melanitis leda* there are no dry-season forms in North-east Sumatra; and Doherty mentions analogous facts in reference to localities with a generally moist climate, like Ceylon and Singapore, and also, *mutatis mutandis*, to dry countries like Sind.† The prevalence of wet-season forms in the equatorial forest region of West Africa is another phenomenon of the same kind. Instances such as these show that a generally damp country may be characterized by a greater abundance of "wet-season" forms, and *vice versâ*. But these cases of the prevalence of "dry" or "wet-season" forms respectively, according to the general climatic conditions of a given locality, are, as we have just seen, accompanied by others which seem to prove that in certain districts, especially perhaps dry ones, the phases that are usually associated with the seasons occur indiscriminately at all times of the year.

Many such instances are recapitulated by Butler in his late revisions of the genera *Teracolus* and *Terias*. *Teracolus eupompe*, Klug, for example, has a wet, an intermediate and a dry phase. "The two latter undoubtedly fly together, and in Aden it is tolerably certain that all the phases emerge at the same time as mere variations." ‡ With regard to *T. halimede*, Klug, Butler observes, "*T. acaste* represents the wet-season phase, *T. halimede* the

* "Die Farbenevolution bei den Pieriden," Tijdschr. der Nederl. Dierk. Vereenig; (2) Deel V, 1898, pp. 179—185, etc. The value of the theoretical considerations based by Piepers on the facts that he has evidently observed with much care, appears to me to be greatly diminished by his refusal to admit the influence of selective adaptation, even as a provisional hypothesis.

† Proc. Ent. Soc. London, 1898, p. lxviii. Compare Watson; Journ. Bombay Nat. Hist. Soc., 1894, vol. viii, p. 489, etc.

‡ Ann. Mag. Nat. Hist., 1897, vol. ii, p. 497.

intermediate, and *T. cælestis* the dry-season phase of the species; but they are none of them confined to seasons, but occur (as is the case with other species in very arid countries) as mere coexistent variations." * Of *T. protomedia*, Klug, he remarks, "At Aden all three [seasonal] types occur together as mere variations." † Other species of *Teracolus* of which similar statements are made are *T. protractus*, Butl., *T. phisadia*, Godt., *T. puellaris*, Butl., *T. vestalis*, Butl., *T. evagore*, Klug, and *T. pleione*, Klug. With regard to *Terias* Butler also notes that, "as in *Teracolus*, those countries which have no wet season nevertheless produce the three phases of a species as coexistent varieties." ‡ There is reason to think that in the New World, at any rate, there may occur a similar intermingling of forms which is not confined to "countries having no wet season." Thus, Messrs. Godman and Salvin write as follows: "Many of these forms [of *Terias*] are said to be due to the season of the year at which they appear, wet-season and dry-season broods having each their peculiar characteristics. These observations have been made chiefly in the east. In our country we have not noticed any phenomenon of this kind." § Mr. G. C. Champion again, if my memory does not deceive me, in the discussion that followed the exhibition of certain specimens of *Callidryas* referred to by Mr. Trimen (*loc. cit.*), many of which were collected by himself, stated that according to his experience of these butterflies, the varying forms of the same species from the same locality had no definite relation to the seasons. Colonel Swinhoe, besides recording the fact that he has taken all the seasonal forms of certain eastern *Teracoli* flying simultaneously at Karachi, has also averred that he has captured *Byblia simplex*, Butl., the supposed dry-season form in India of *B. ilithyia*, Drury, practically all the year round. Some doubt has been thrown by de Nicéville and by Marshall on the latter observation; the

* Ann. Mag. Nat. Hist., 1897, vol. ii, p. 502. The dates of Col. Yerbury's captures at Aden clearly prove the simultaneous occurrence of different "seasonal" forms, but they do not seem incompatible with a certain amount of correspondence on the part of these phases with the time of year. See, *e. g.*, the dates given for *Teracolus cælestis* and *T. acaste*; Proc. Zool. Soc., 1884, pp. 489, 490.

† Ann. Mag. Nat. Hist., 1897, vol. ii, p. 507.

‡ *Ibid.*, 1898, vol. i, p. 57.

§ Biologia Centrali-Americana. Rhopal. ii, p. 154.

former, however, says Butler, is a fact that can be proved from the data on the Museum specimens.*

Statements of this kind, the list of which could be largely extended, go far to show that the case of *Catopsilia pomona* and *C. crocale* is by no means an isolated one, and that just as there are regions in which more than one geographical form of a widely-ranging species may be found flying together,† so there are districts of a greater or smaller extent where diverse forms of a species, confined for part of its range to definite seasons, may all occur simultaneously. No doubt the data are as yet insufficient for a complete explanation of these phenomena. It seems, however, clear that the forms or phases which are usually called "seasonal" may occur under many diverse conditions and in many different proportions. It appears further that they do not fall into a regular system of succession, except in the presence of regular alternations of season, and not always then. I still venture to think that a probable view concerning many of them is that briefly expressed by me some years ago in "Nature" (Vol. lx ; 1899, p. 98), viz., that polymorphism, however it may have arisen, is capable of being brought more or less into relation with locality and season under the influence of natural selection. On the other hand, it is conceivable that in some cases at all events the forms in question may have first arisen as adaptations to the seasonal changes, and afterwards, in consequence of extending their range, or of some other alteration of conditions, may have partly or entirely lost

* Ann. Mag. Nat. Hist., 1897, ii, p. 386 ; *Ibid.*, 1896, ii, p. 335. The following instances may be added from specimens with data in the Hope collection :—(1) Australian form of *Terias hecabe*, Linn. (*T. sulphurata*, Butl.) ; the dry, wet, and intermediate seasonal forms, all taken by Mr. J. J. Walker, R.N., on June 19, 1890, at Port Darwin, North Australia. (2) *Teracolus phlegyas*, Butl. (*T. difficilis*, E. M. Sharpe) ; a wet-season male taken paired with a dry-season female, both in good order, by Mr. G. A. K. Marshall, May 3, 1899, at Salisbury, Mashonaland. (3) *Teracolus vestalis*, Butl. ; the wet and dry-season forms both taken at Karachi on May 10, 1888, by Mr. W. D. Cumming. (4) *Belenois severina*, Cram. ; wet and dry-season forms both taken on Feb. 13, 1897, at Karkloof, Natal ; a wet-season male paired with a wet-season female, and another wet-season male with a dry-season female on Feb. 24, 1897, at Malvern, Natal. All these by Mr. G. A. K. Marshall.

† *E. g.* the various forms of *L. chrysippus*, Linn., which are all found together at Aden. See Butler in Proc. Zool. Soc., 1884, pp. 478–481 ; and Col. Yerbury in Journ. Bombay Nat. Hist. Soc., 1892, p. 209.

their correspondence therewith. These are questions that must, I think, for the present remain unanswered; though whatever the solution may be, there seems no need to anticipate that it will weaken the case for selective adaptation.

### 4. Experiments and Observations in Seasonal Dimorphism conducted by Mr. G. A. K. Marshall, F.Z.S., in the years 1896—1901.

In the "Annals and Magazine of Natural History," 1901, ii, p. 403, Mr. Marshall writes as follows:—"Two years ago I made a few experiments in applying moist heat to the pupæ of several species of *Teracolus*. Unfortunately all my notes on the subject have been lost, but, so far as I can recollect, the results were almost entirely negative, which I then attributed to insufficient heat. The resulting specimens were, however, sent to the Oxford University Museum with full data." There are also in the Hope collection several other specimens, collected by Mr. Marshall in 1896 and following years, which are of considerable interest in their bearing on the subject of Seasonal Dimorphism. By the kindness of the Hope Professor, I am permitted to give Mr. Marshall's own comments on both series of specimens. These are contained in private letters to Professor Poulton, and have not hitherto been published. I propose to arrange the notes in chronological sequence; but it will be seen that the experiments fall into two main groups, which are more or less intermingled in order of time. The first group of experiments includes cases where one form of a species was reared under normal conditions from eggs laid by another form of the same species. In the second group of experiments, the pupæ, or sometimes the larvæ in their later stages as well as the pupæ, were subjected to artificial conditions in order to see whether any effect could be thereby produced on the following emergence. It is well known that very striking results have been brought about by artificial conditions of temperature in the case of dimorphic butterflies in Europe and North America. The names of Dorfmeister, W. H. Edwards, Weismann, Merrifield and Standfuss, to say nothing of others, will occur to every one as those of the authorities to whom we owe nearly

the whole of our knowledge in this particular. In view of the great difference between the temperate and tropical seasons, it was natural to suppose that the seasonal forms of tropical butterflies would be found to stand in relation to quite other meteorological conditions than those responded to by the Nearctic and Palæarctic species which had previously formed the subject of experiment. So far as I am aware, the only factor found generally operative in these latter cases is a raising or lowering of the temperature; the direct effect of humidity has been tried, but almost always with negative results. Mr. Marshall, on the other hand, has successfully used heat in combination with both moisture and dryness, and has also employed moisture unaccompanied by heat. By all these means, as will be seen, he has secured results analogous indeed with those of the European observers, but as a rule far less complete. It is possible that there may still be discovered some factor or combination of factors which will produce, in dimorphic tropical species, equally striking results with those to which Merrifield and Standfuss have now accustomed us. Most, however, of the species so far investigated by Mr. Marshall have proved comparatively resistent to this kind of treatment, and he has no instance of artificial modification which can be ranked with the *Araschnia levana* of many experimenters, or the *Selenia tetralunaria* of Mr. Merrifield.

Mr. Marshall's initials are here appended to each separate extract from his correspondence.

"*Estcourt, Natal; Dec.* 14, 1896.—I only succeeded in getting three eggs of *Teracolus topha*,* of which I send you one of the resulting specimens, which is undoubtedly *T. auxo*, being of the early wet-season form with the upper side black markings not yet fully developed. The eggs were laid within five minutes of one another, and they hatched simultaneously, but one larva pupated a day later than the other two and emerged a day later. The first two examples

* The result of this experiment was communicated by Mr. Marshall to the "Entomologist's Monthly Magazine," 1897, p. 52, and is referred to by Mr. Trimen in his address above quoted (Proc. Ent. Soc. Lond., 1898, p. lxxii). It should be noted that the name *T. topha*, Wallgrn., which is now used by both Mr. Marshall and Mr. Trimen to designate the dry-season form of *T. auxo*, is considered by Dr. Butler to be applicable rather to an intermediate form between *T. auxo* and *T. keiskamma*, Trim., the latter being the true dry-season phase. (Ann. Mag. Nat. Hist., 1897, ii, p. 453.)

(of which yours is one) are quite similar, but the third has the black edging to the apical patch of the forewing a trifle heavier, and also shows a trace of the black line along the inner edge of the patch characteristic of the full summer form. As the eggs were all laid by the same female, and the larvæ were reared under absolutely similar conditions, it would seem at first sight that the heavier markings could only be due to the longer larval stage, but this seems highly improbable. I was astonished at the rapid development of this species; egg-stage, three days; larval stage, twelve to thirteen days; pupal stage, eight days. Total, twenty-three to twenty-four days. From this I should estimate that there must be from nine to ten broods in the year."—G. A. K. M.

The above-mentioned specimen, a male, is now in the Hope collection, and entirely bears out Mr. Marshall's description. It is a well-marked, but not extreme example of the "wet-season" form *T. auxo*, Luc. Mr. J. Mansel Weale's experience of the same species is well known; * and it may be noted that of five bred examples sent to the Hope collection by Mr. Weale in 1878, there is a pair each of the *auxo* (wet) and *taphu* (dry) form, together with a single female of an intermediate phase. Mr. Marshall's experiment removes the subject of the specific identity of these several forms from the region of probable conjecture to that of proof.

"*Estcourt, Dec.* 14, 1896.—While staying with Mr. Burn, at the junction of the Blaauwkraantz River with the Tugela, I tried to see whether the black markings of the early wet brood of *Teracolus annæ* could be intensified by damp surroundings, so as to resemble those of the full wet form. For this purpose I had a tin half filled with wet sand, in which I stuck the pupæ on thin sticks, covering it over with a cloth on which was a wet sponge. Into this I put five freshly-turned pupæ, of which I kept three in for seven days and two for nine. Only one specimen emerged out of each lot, and so far as I can see there is absolutely nothing unusual about either of them. Although the results of the experiment are negative, they are interesting, in that they *tend* to show that cold moisture cannot accentuate the black markings of the wet-season form, and also that cooler surroundings (induced by evapor-

* Trans. Ent. Soc. Lond., 1877, p. 273. See also Mr. Barker's comments; *Ibid.*, 1895, p. 422.

ation) do not tend to cause a reversion to the dry-season form. The first lot of *T. annæ* I bred (under ordinary conditions) were in pupa during fine warm weather, and took nine days to emerge. Those placed in the damp tin took in both cases twelve days. Three other pupæ kept under ordinary conditions were also twelve days in pupa, the last six days being cold, wet weather; these however were all of the full wet form, one female being even blacker than usual. With this species I observed that the bred specimens were nearly always more advanced in coloration than freshly emerged captured specimens."—G. A. K. M.

Eight of the specimens of *T. annæ*, Wallgrn. above referred to, are now in the Hope collection. One of these emerged on Nov. 17, 1896, after a pupal stage of twelve days, during seven of which it was kept in the damp tin jar, as above stated. It is an ordinary wet-season male, not extreme in character. A well-marked wet-season female, also in pupa twelve days, but under usual conditions, emerged on Nov. 11. This may be the female mentioned above. The only other bred specimen is a well-marked wet-season male, decidedly darker than the first. It emerged on Nov. 13, but there is no note as to its duration in the pupal state. The remaining five specimens were caught in the open. A female taken on Nov. 6 is wet-season; a pair on Nov. 12 are intermediate, as are two males taken on Nov. 14 and Nov. 16 respectively.

"*Estcourt, Dec.* 14, 1896.—On my return here I attempted a small test experiment as a converse of the former one, viz., submitting pupæ to dry warm conditions. My *modus operandi* was as follows: on a tripod stand I placed a round tin containing a little water; on the mouth of the tin was a china saucer filled with dried sand, in which were placed the pupæ beneath an inverted glass, the water being warmed by a spirit-lamp. Into this I put a suspended larva of *Byblia ilithyia*, a pupa seven days old, and another two days old. I applied too much heat at first, keeping the water at a boil, which killed the larva. I then turned the lamp as low as possible, keeping the tin just hot enough for the hand to bear. The older pupa emerged in three days (normal pupal stage, thirteen to fifteen days) and presents no marked peculiarity, as you may see, being of the early wet-season form, which was the only form occurring at that time in the natural state. The last

pupa emerged after six days' heating (eight days in pupa); unfortunately it had a difficulty in emerging, and I arrived too late to help it. But such as it is, it seems to me a very interesting specimen, for it is clearly intermediate in colouring, being therefore a step backwards towards the dry form. Its intermediate character is shown on the underside of hind wings, in the deeper ground-colour and more accentuated white bands, and on the upper side by the broad interruption about radial nervules of the submarginal black line in forewings, a character which only occurs in the dry or intermediate form of the female, and never in the early wet form of that sex."—G. A. K. M.

The two specimens here mentioned are both in the Hope collection. The difference between them is marked, the one which emerged on Nov. 27, from the pupa which was already seven days old before being exposed to dry warmth, being a wet-season male of the ordinary kind; while the other, which was only two days old when subjected to the same dry warmth, emerging on Nov. 30, is a crippled female, distinctly of the dry-season form, not extreme, but quite unmistakable, and entirely differing from specimens captured in the same locality at the same time of year.

"*Malvern, Natal; Feb.* 21, 1897.—I have been trying to find some reason to account for the occurrence of the marked varieties of *Biblia ilithyia*. This again is a widespread and common species, and comparatively conspicuous, so that there must be some sort of protective agency at work. I can only explain it by the fact that *B. ilithyia* strongly suggests an *Acræa* on the wing. Its general coloration, somewhat elongated wings and flapping flight (so different from that of its congeners), all tend to suggest this. That the typical form does not actually resemble any species of *Acræa* is of course plain, but I certainly regard the variety *acheloia* as a marked stage of incipient mimicry. On the underside, the hindwing of this variety, in its wet-season form, differs from that of the type in having lost the whitish bands, which gives it a very marked resemblance to *Acræa serena-buxtoni*. Again, the loss of the discal row of spots on the upper side of the hindwing points the same way, and it is interesting to note that, so far as my experience in South-east Africa goes, where *A. serena-buxtoni* occurs, there *acheloia* prevails over the typical form. Again, the chief difference between

the Central African *serena* and its southern sub-species is that in the former the black band near the apex of the forewing is continuous, but broken in the latter. If I remember right, there is a somewhat similar difference between *achaloia* and its Central African form *goetzius*, which, if correct, would further bear out my idea. Now as to the winter form; the underside of this is of course quite unlike that of any *Acræa*, and I can only suppose that it is a case of protective resemblance on the principle of the zebra's or tiger's stripes, for the insect always roosts on grass. It is interesting to note however that that part is undergoing modification in the variety *achaloia*, as the marginal white line in both wings has already done. It would be interesting to know whether there is any likeness between this species and the Indian *Acræas*."—G. A. K. M.

As I have elsewhere stated, I consider that *Byblia götzius*, Herbst, which Mr. Marshall here speaks of as *B. ilithyia* var. *achaloia*, is entitled to distinct specific rank beside *B. ilithyia*, Drury. Mr. Marshall's observation with regard to the continuity of the apical black band of the forewing in the Central African form of *B. götzius* is borne out on an examination of specimens in the Hope collection and the British Museum. It was remarked by me some time since, in discussing the modifications of *B. ilithyia* and its allies, that "the Socotran *B. hoydi* resembles most specimens of *B. götzius* from the West African subregion in having the dark costal bar of the forewing continued rather heavily across the wing to join the submarginal band. This is also more or less the case with two females of *B. götzius* from Abyssinia, and specimens of the same from Somaliland and Aden in the British Museum; but in examples from South and East Africa the connection between the costal and the submarginal dark bands is often slight or absent." * It is worth noting that the marginal white line spoken of by Mr. Marshall, on the underside of both wings in the dry-season form of *B. ilithyia*, has disappeared from the dry-season *B. götzius*, but persists in *B. hoydi*, of which only the dry-season form is at present known. This is another indication of the intermediate position of the latter insect, which, though nearer to *B. götzius*, yet shows several points of resemblance to *B. ilithyia*.

* Proc. Zool. Soc., 1898, p. 378.

On the whole Mr. Marshall's view as to the incipient mimicry of *Acræa serena*, Fabr., by *B. götzius* seems a very probable one. The underside of the wet-season *B. ilithyia* perhaps recalls slightly that of the Indian *Acræa* (*Telchinia*) *violæ*, Fabr., but the likeness in this case is of a remote kind.

"*Malvern, Natal; May* 14, 1897.—*Experiments on submitting pupæ to conditions of moisture or dry heat.* The apparatus used for dry-forcing was a covered tin (into which was poured a little water) placed on a tripod over a spirit-lamp. On the lid of the tin was placed some dried sand, into which was stuck a stick bearing the pupæ, which were covered with an inverted glass. The 'damp tin' contained very damp sand, the pupæ being separated from it by a grating of perforated zinc; and the mouth of the tin was covered with a cloth, on which was placed a wet sponge.

"Experiment with *Acræa cabira*.

1897

March 26. Two larvæ (*a* and *b*) pupated this morning; I put them in the dry forcer in the evening.

„ 28. A larvæ (*c*) pupated, and was left in the breeding-cage.

„ 31. Two larvæ (*d* and *e*) pupated; *d* put in the forcer, *e* left in breeding-cage.

April 6. *e* emerged, being a normal male.

„ 8. *e* emerged, a normal female; *d* not yet emerged, but still alive; *a* and *b* probably dead.

„ 9. *d* evidently too weak to emerge, so I helped it out, but it was only just alive, and wings did not expand. Its colouring was apparently normal. *a* and *b* never emerged at all, but shrivelled up.

"*Result.*—*Acræa cabira* apparently unable to exist in a very dry, hot climate, as might be supposed from its distribution. It is noteworthy that two pupæ of *Terias brigitta* emerged satisfactorily in forcer during the same period.

"Experiment with *Pinacopteryx pigea*.

1897

April 2. Seven larvæ (*a* to *g*) pupated.

1897

April 3. Put two pupæ (*a* and *b*) in dry forcer; two more (*c* and *d*) in damp tin; and left three (*e*, *f* and *g*) in breeding-cage.

„ 9. Took *c* and *d* out of damp tin, as they showed signs of emergence.

„ 10. *a*, *c* and *e* emerged in the morning. *a* was a female of the yellow form, showing an approach to the dry-season form in a slight reduction of all the black spots and borders, especially the discal spot in fore-wings; *c* was a female of the white form, and had all the black spots well marked; *e* was a white female, intermediate in the development of black markings between *a* and *c*.

Removed *b* from forcer to breeding-cage.

„ 11. *b*, *d*, *f* and *g* emerged. *b* was a white female in which the black markings were not quite so light as those of *a*, but noticeably lighter than those of *c*; *d* was a normal wet-season male; *f* and *g* were yellow females intermediate in markings between the extreme forms *a* and *c*.

"*Result.*—The differences exhibited are slight, but so far as they go they apparently tend to show that the effect of dry heat is to reduce the black markings, and that of cool moisture to enhance them. It is to be observed that yellow and white forms of the female occur at both seasons, the deeper yellow specimens are however more prevalent in winter. Reliable *seasonal* distinctions are greater or less development of the marginal black spots and discal spot in forewing, combined with less or greater acuteness of forewing.

"Experiment with *Crenis boisduvalii*.

1897

April 9. Twenty-two larvæ of *C. boisduvalii* pupated.

„ 10. Put six pupæ into dry forcer; six into damp tin; and left the rest in breeding-cage.

„ 14. Six pupæ in forcer emerged; there were four male and two female, but two of the former were deformed.

1897.

April 15. Three males and three females emerged in damp tin; one male escaped and another was deformed. Three males and six females also emerged in breeding-cage.

"On comparing the three sets of specimens the differences were found to be remarkably slight, all the specimens being of a more or less intermediate character between the wet and dry season forms (as might be expected during this month for those bred under normal conditions). But such slight differences as do exist appear to be fairly constant. In the females the black patches on the underside of the forewings are constantly best developed in those from the damp tin and least in those from the forcer. Those reared under normal conditions are much nearer the former in this respect, being all rather lighter, except examples which are hardly separable from those reared under moist conditions. The differences in the hindwings are too slight to be taken into account. In the males those from the forcer show a slight difference from the rest in having the black mark on the underside of the forewing somewhat reduced, and a greater suffusion of ochreous scales on the upper side of the hindwing. The others are practically inseparable. The seasonal differences in this species are very clearly defined as a rule.

"Second Experiment with *Pinacopteryx pigea*.

1897.

April 8. Six larvæ pupated (*a* to *f*).

„ 9. Two larvæ pupated (*g* and *h*). Put *a*, *b* and *c* into dry forcer, and *d* and *e* into damp tin.

„ 10. Two larvæ (*j* and *k*) pupated. Put *g* into damp tin.

„ 15. Removed *a* and *b* from forcer to breeding-cage; *c* was dead; cause unknown.

„ 16. *a* and *b* emerged; both females.

„ 17. *f* and *h* emerged in breeding-cage; both females.

„ „ *d* emerged in damp tin; female.

„ 18. *e* emerged in damp tin; female.

„ „ *j* emerged in breeding-cage; female.

„ 19. *g* and *k* emerged in damp tin and breeding-cage respectively; both males.

"No notes were kept of individual markings, but on comparing the three sets it was noticeable, as in previous experiments, that considering the disparity of conditions, the markings showed wonderfully little difference. It is however indisputable that, taking the specimens in conjunction with those of the previous experiment, all those subjected to dry heat had the black markings appreciably less developed than those whose pupæ were kept in a cool, moist atmosphere. Those that were reared entirely in the breeding-cage are mostly of an intermediate type of colouring, though two are quite as bright as the heated specimens, but none of them resemble those that were kept damp.

"It is noteworthy that in *Crenis boisduvalii* the specimens reared under normal conditions showed just the opposite tendency.

"Although the experiments are on far too small a scale to *prove* anything one way or the other, yet to my mind they appear to lend more support to the theory that the heavier development of black markings in South African butterflies during the summer is probably more dependent on the prevalence of moisture than on the action of heat: though the very small effects shown by these agents in the above experiments suggest the supposition that the absence or presence of black markings alone cannot be referred entirely to climatic agency, as I had been previously inclined to think, but have been developed by natural selection, for some purpose not at present apparent, which has worked on the slight tendency to variation caused by climatic influence."—G. A. K. M.

In 1896 Mr. Marshall had exposed some larvæ of *Acræa anacreon* to "dry-season" conditions just before pupation, but they all died in consequence, as he believes, of overheating (Estcourt, Oct. 15, 1896). On Oct. 7, 1897, he writes from Malvern: "The experiment in which I found that the pupæ of *Acræa cabira* were killed by dry heat which did not affect *Terias brigitta*, leads me to think some of these highly-developed nauseous species may have suffered in hardness of constitution, which would account for their not spreading more widely than they do."

Of the specimens referred to by Mr. Marshall in the two series of experiments on *Pinacopteryx pigea*, Boisd., *a*, *c* and *e* of the first series, and *a*, *b*, *d*, *e*, *f* and *h* of the second series are in the Hope collection. The divergences noted

as the result of the different treatment are more easily visible in the first series than in the second.

The Hope collection also possesses seven specimens of the above-mentioned series of *Crenis boisduvalii*, Wallgrn. These are a pair of the "dry heat" emergence on April 14; a pair of the "damp tin" emergence on April 15; and a male and two females which emerged under normal conditions, also on April 15. There is no doubt that the "dry heat" female is considerably lighter on the upper surface, and has the dark marks on the under surface of the forewings less distinctly marked than any of the others. The differences between the males are of the same kind, but somewhat less apparent.

"Aug. 29, 1899.—I am sending you by this mail a small lot of butterflies, including the bred *P. sesamus* and *archesia*, and twenty-one bred specimens of *Teracolus omphale* and *T. achine*, with their respective parents. . . . The *Teracoli* will be valuable as actually proving seasonal dimorphism in these species. I must admit that I was much surprised to find that the warm, damp atmosphere had no effect on *T. omphale* (D1—4) whatever.* The apparatus I used was a very deep circular tin (uncovered), which was partially filled with water, in which was placed a stand; to this the pupæ were pinned, they being about four inches above the water. In the case of *T. omphale* (D1—4) I kept the spirit-lamp with only a tiny flame, so as to keep the water just hot, and so that a faint warmth could always be felt on placing the hand above the mouth of the containing tin. On account of the negative results thus obtained, I came to the conclusion that the heat applied was perhaps insufficient in all these cases. Unfortunately, I had not enough material left to test this properly, but in the case of *T. achine* (C1 and C2) I kept the water at about 180° F., still keeping the tin uncovered, and, as you will see, this has undoubtedly had a more decided effect, especially in the case of C2, which was put in before actual pupation. I was, however, surprised that with C1 the protectively coloured under side should have been affected, rather than the black markings of the upper side. In view of this result I think the previous experiments must not be taken as conclusive. Among the *Teracoli* there

* It appears to me to have had a slight effect, as can be seen on comparing D2, D3 and D4 with D5, D6 and D7. See pp. 211–13.—F. A. D.

is a highly interesting female *omphale* (E, No. 15)."—G. A. K. M.

The specimens of *Teracolus* here spoken of were all obtained at Salisbury, Mashonaland. They are as follows:—

1. *Teracolus achine*, Cram.

X. A "wet-season" female (Figs. 5, 5*a*). Captured March 26, 1899. Laid one egg.

X1. Offspring of X. From egg laid March 26; hatched March 31; pupated April 23; kept under normal conditions; emerged May 9. A "dry-season" female, not extreme, corresponding to the form described by Trimen (South African Butterflies, vol. iii, 1899, p. 136) as *T. antevippe*, Boisd., ♀. (Figs. 6, 6*a*.)

B. An "intermediate" female. Captured April 23, 1899; laid 15 eggs.

B1. Offspring of B. Egg laid April 23; hatched April 29; pupated June 12; kept under normal conditions; emerged July 20. A dry-season male, corresponding to *T. antevippe*, Boisd., as described by Trimen, *loc. cit.*

B2. Offspring of B. Egg laid April 23; hatched April 29; pupated June 15; kept under normal conditions; emerged July 22. A well-marked dry-season male, the pink of the hindwing under side more pronounced than in B1. The left hindwing is not completely expanded.

C. An intermediate female, verging towards "dry." Captured April 26, 1899; laid 17 eggs.

C1. Offspring of C. Egg laid April 26; hatched May 3; exposed to damp heat from 10 p.m., June 22, to 8 a.m., July 4. Emerged July 7. An intermediate male, on the under side resembling the wet-season form.

C2. Offspring of C. Egg laid April 26; hatched May 3; exposed to damp heat from 10 p.m., June 22, to 8 a.m., July 4; pupated 8 a.m., June 23; emerged July 8. An intermediate male, like C1, but somewhat more closely approaching the wet-season form on the upper surface.

C3. Offspring of C. Egg laid April 26; hatched May 3; pupated June 22; kept under normal conditions; emerged July 29. A male, intermediate on the

upper surface, but with the under side decidedly of the dry-season type.

C4. Offspring of C. Egg laid April 26; hatched May 3; pupated June 28; kept under normal conditions; emerged Aug. 3. A dry-season female.

2. *Teracolus omphale*, Godt.

D. A wet-season female (Figs. 7, 7*a*). Captured April 26, 1899. On the same day laid 19 eggs, which hatched on May 3. Seven of the resulting butterflies are in the Hope collection, as follows :—

D1. Exposed to damp heat from 6 p.m., June 17, to 11 p.m., June 25; pupated 11 p.m., June 17; emerged June 27. A dry-season male, crippled.

D2. Pupated 2 p.m., June 17; damp heat 6 p.m., June 17, to 11 p.m., June 25; emerged June 27. A yellow dry-season female, imperfectly expanded.

D3. Damp heat 6 p.m., June 17, till emergence; pupated 8 p.m., June 17; emerged June 28. A yellow dry-season female.

D4. Pupated 2 p.m., June 17; damp heat 6 p.m., June 17, to 11 p.m., June 25; emerged June 29. A dry-season male, not extreme.

D5. Pupated June 10; normal conditions; emerged July 12. A white dry-season female, more advanced than D2 and D3; as shown by the diminution of the dark markings on the upper surface, and the disappearance of the transverse bar and orange-shaded discoidal spot on the under side of the hindwing, traces of these being visible in both the females D2 and D3, which had been exposed as pupæ to damp heat.

D6. Pupated June 10; normal conditions; emerged July 14 (Figs. 8, 8*a*). A white dry-season female, still more advanced than D5.

D7. Pupated June 16; normal conditions; emerged July 17. A dry-season male, more advanced than D4.

E. A yellowish wet-season female. Captured April 30, 1899. Laid 15 eggs the same day. Offspring :—

E1. Hatched May 8; pupated June 28; normal conditions; emerged July 25. A white dry-season female, with dark markings on disc of forewing greatly reduced, and with a yellowish shade re-

placing the orange in the centres of the apical interspaces. This is the specimen referred to by Mr. Marshall as E, No. 15 (p. 210).

E2 and 3. Hatched May 8; pupated June 28; normal conditions; emerged July 26. Two dry-season males.

F. A wet-season female. Captured May 3, 1899. Laid 2 eggs, which hatched on May 9. Offspring:—

F1. Pupated June 27; normal conditions; emerged July 26. A dry-season male.

F2. Pupated June 28; normal conditions; emerged July 26. A yellow dry-season female, not extreme.

G. A wet-season female. Captured May 10, 1899. Laid 10 eggs. Offspring:—

G1. Hatched May 18; reared under normal conditions; emerged July 31. A white dry-season female, not extreme.

G2. Hatched May 18; normal conditions; emerged Aug. 3. A dry-season male.

In all the above cases, the "dry-season" offspring of the parent *Teracolus omphale* corresponds generally with the form described by Mr. Trimen (South African Butterflies, vol. iii, 1889, p. 145) as *T. theogone*, Boisd. The specific identity of these two forms had long been suspected, and by the above series of specimens is placed absolutely beyond doubt.

In 1898 Mr. Marshall sent home a collection of butterflies from Salisbury, Mashonaland, which was described by Dr. Butler in Proc. Zool. Soc., 1898, pp. 902–912. In an accompanying letter to Dr. Butler he says: "I am somewhat in doubt as to the *Teracoli* I have sent you labelled *pallene*, for they are practically indistinguishable from the extreme dry form of *omphale;* yet the wet form is certainly not *omphale*, which I do not remember ever to have seen here, but seems referable to *pallene*." Dr. Butler (*loc. cit.*, p. 911) "has not the least doubt that these examples are ordinary *T. omphale*." An examination of similar specimens sent to the Hope collection by Mr. Marshall as *T. pallene*, led me independently to the same conclusion as Dr. Butler; and it is worthy of notice that while several of the bred examples just described are not separable from Mr. Marshall's specimens of *T. pallene*, the four parents, all of which were captured at Salisbury, are identified by Mr. Marshall himself as *T. omphale*. The inference seems

clear that there is no reason for considering Mr. Marshall's "*T. pallene*" from Mashonaland as specifically different from *T. omphale*.

It will be seen from the above descriptions that the damp heat to which many of the specimens of *T. omphale* were exposed was not entirely without effect; though the changes in the direction of the wet-season form are no doubt less marked than those produced in the case of *T. achine*, where the heat employed was greater.

3. *Teracolus phlegyas*, Butl.* (*T. difficilis*, E. M. Sharpe).

One specimen: Salisbury, Mashonaland. Larva suspended June 6, 1898; placed in damp forcer June 7; pupated same day; removed June 30; emerged June 31. An intermediate female, on the whole nearer to the dry than to the wet-season form. The dark markings on the upper surface of the forewings, including the discoidal spot, are, however, somewhat strongly developed for a dry-season form; and there is a well-defined grey basal patch, but no dark inner-marginal bar. Beneath, the hindwings have lost the definite spots of the wet-season phase, but have not assumed the dry-season colouring in its full development.

This completes the list of specimens of *Teracolus* mentioned by Mr. Marshall in his letters. The succeeding extracts bear reference to the African forms of the genus *Byblia*, Hübn.

"April 25, 1899.—I have a few authentic eggs of *Byblia ilithyia* and *acheloia*, which may perhaps decide the justice of Dixey's contention as to the specific validity of the latter.

"April 19, 1901.—I hope to be able to get some definite evidence as to *Byblia*, as I have now five pupæ and three larvæ bred from authenticated eggs of *ilithyia*, and one pupa and six larvæ from those of *vulgaris*, *i. e.* the wet-season form of *B. acheloia* (= *B. götzius*). The resulting butterflies will also prove the seasonal variation in the two forms. So far as my present material goes, I find that there is a very slight colour-distinction between the two larvæ in the last stage only.

"Sept. 27, 1901.—The specimens resulting from my damp experiments, together with those already sent, might

* This, though belonging to an earlier series of experiments, is inserted here for convenience

form the nucleus of a most interesting and instructive series to show the experimental evidence as to the proximate causes of seasonal dimorphism. . . . . You will find some of the specimens from my *Byblia* experiments. The few that emerged all bred true to their parents, but the principal evidence consists in a slight, though constant, colour-distinction which I found in the larvæ of the two insects, thus proving them to be distinct species."—G. A. K. M.

It is satisfactory to me to find that in consequence of his latest experiments, Mr. Marshall now holds the view as to the specific distinction between the two continental forms of *Byblia* which I felt justified in putting forward in 1898.* The specimens recently forwarded by him to the Hope collection from Salisbury, Mashonaland, are as follows:—

A. *B. ilithyia*, Drury. A worn wet-season female. Captured March 17, 1901. Laid 3 eggs. Offspring:—

A1. Hatched March 21; pupated April 11; emerged April 28. A wet-season female.

A2. Hatched March 21; pupated April 11; emerged April 29. An intermediate male.

B. *B. ilithyia*, Drury. A worn wet-season female (Fig. 1). Captured March 17, 1901. Laid 5 eggs. Offspring:—

B1. Egg laid March 24: hatched March 28; pupated April 11; emerged April 29. An intermediate male.

B2. Egg laid March 24: hatched March 28; pupated April 11; emerged April 30. An intermediate female (Fig. 2).

B3. Egg laid March 24; hatched March 28: pupated April 11; emerged May 1. An intermediate male.

C. *B. götzius*, Herbst. A worn wet-season female, of the form *vulgaris*, Staud. (Fig. 3). Captured March 24, 1901. Laid 6 eggs. Offspring:—

C1. Egg, March 24; hatched March 28; pupated April

* Proc. Zool. Soc., 1898, p. 376. The current number (Feb. 1902) of the "Entomologist's Monthly Magazine" contains the first instalment of a paper by Mr. Marshall in which he gives a detailed account of his experiments in the breeding of *Byblia ilithyia* and *B. götzius*, with descriptions of larvæ and pupæ.

22; emerged May 8. A dry-season male, of the form *acheloia*, Wallgrn. (Fig. 4).

C2. Egg, March 24; hatched March 28; pupated April 24; emerged May 13. A dry-season male, like C1.

E. *B. ilithyia*, Drury. A wet-season female. Captured March 24, 1901. Laid 2 eggs. Offspring:—

E1. Egg, March 24; hatched March 28; pupated April 27; emerged May 19. An intermediate male.

These specimens supply complete proof, if proof were wanted, of the specific identity of *B. vulgaris*, Staud. with *B. acheloia*, Wallgrn., and also of *B. ilithyia*, Drury, with the African form corresponding to *B. simplex*, Butl., of India. It is to be noted that none of the bred *B. ilithyia* are of the full dry-season form. One or two of them, however, approach it so closely as to leave no manner of doubt that later in the year the typical "dry-season" colouring would be developed.

The following specimens of *Terias* sent home by Mr. Marshall are also worthy of note:—

*Terias brigitta*, Cram.

A. Malvern, Natal. Pupa in dry heat 6 days; emerged April 4, 1897. A wet-season male.

This is no doubt one of the two *T. brigitta* mentioned above (p. 205) as having withstood an amount of heat which proved fatal to *Acræa cabira*.

B. Malvern, Natal. Pupa under normal conditions; emerged April 9, 1897. A wet-season female.

*Terias senegalensis*, Boisd.

A. Salisbury, Mashonaland. Captured April 7, 1901. (Figs. 9, 9*a*.) Laid 3 eggs. A wet-season female of *T. senegalensis*, Boisd. Offspring:—

A1. Egg laid April 7; hatched April 11; emerged June 10. (Figs. 10, 10*a*.) A dry-season male, of the form *T. æthiopica*, Trimen.

These two specimens are of great interest, as showing that a *T. hapale*-like form (*T. æthiopica*) may be bred from a *T. hecabe*-like parent (*T. senegalensis*); and as thus tending in some respects to confirm Mr. Marshall's view expressed to Dr. Butler in 1898 as follows:—

"You will notice among the *Terias* that I have pointed

out that *T. æthiopica* and *butleri* of Trimen are respectively dry and wet forms of the same species, and thus, taking the synonymy given in your revision, *hapale* must fall as a seasonal form of *senegalensis*. I have not actually proved the case by breeding, but I think you can take my observations on trust now."* I may mention that I had some time ago come independently to the conclusion that the *T. hapale* forms could not be specifically separated from the *T. senegalensis* assemblage, and had arranged the examples in the Hope collection in accordance with that view. But I do not think that even now the seasonal relations of these forms are quite clear.

In addition to the series just described, Mr. Marshall has also presented to the Hope collection the greater number of the specimens resulting from the experiments recorded by him in the "Annals and Magazine of Natural History," 1901, vol. ii, p. 398. They exemplify the very slight effect produced on the early dry-season broods by subjecting the larvæ and pupæ to conditions of moisture without heat. In Mr. Marshall's opinion, the amount of occasional inclination towards the wet-season form shown in this series is no more than might have been met with in examples of similar dates caught in the open. These specimens need no further notice here, having been fully dealt with by Mr. Marshall in his paper above referred to.

## 5. Summary.

The main points of the present paper may be summarized as follows:—

1. *Catopsilia pomona*, Fabr. (including *C. catilla*, Cram.), and *C. crocale*, Cram. are phases of a single species. In at least one part of its range, these phases appear to be in relation with the seasons; in other parts there seems to be no such connection.

2. In like manner *Catopsilia pyranthe*, Linn. is conspecific with *C. gnoma*, Fabr. Here the association of each form with its own season is better recognized, but there is reason to think that even in this case the relation by no means obtains universally.

3. There are many other instances on record of the simultaneous occurrence in a given locality of forms of a

* Proc. Zool. Soc., 1898, p. 909.

species which are either known to be characteristic of the seasons in other parts of the range of the species, or which at least are analogous with proved cases of seasonal dimorphism.

4. Some of these cases of simultaneous occurrence are undoubtedly due to an overlapping at the change of seasons. In other instances the intermingling of the different forms takes place indifferently all the year round. This is perhaps more especially apt to occur in regions where the climate does not show very well-marked alternations between wet and dry.

5. Mr. Marshall has proved the specific identity of the following pairs of forms by actually breeding one from the other:—(*a*) *Teracolus topha*, Wallgr., and *T. auxo*, Luc.; (*b*) *Teracolus achine*, Cram., and *T. antevippe*, Boisd.; (*c*) *Teracolus omphale*, Godt., and *T. theogone*, Boisd.; (*d*) *Terias senegalensis*, Boisd., and *T. æthiopica*, Trim.; (*e*) *Byblia götzius*, Herbst (*vulgaris*, Staud.), and *B. acheloia*, Wallgrn.; (*f*) *Byblia ilithyia*, Drury, and the African form of *B. simplex*, Butl. In each of these cases it was already known that the different forms were respectively associated with different seasons, but the actual proof of specific identity afforded by "breeding through" had hitherto been wanting.

6. The final stage can in many cases be influenced by the artificial application of heat or moisture during the pupal condition. Thus, Mr. Marshall has found that dry warmth may cause the early wet-season form of *Byblia ilithyia* to approach the dry-season type of coloration; while the intermediate or early dry-season forms of *Pinacopteryx pigea* and *Crenis boisduvalii* were slightly affected in the same direction. Warmth in conjunction with moisture produced in early dry-season forms a tendency to revert to the garb of the rains. This was well seen in *Teracolus achine*, and to a less extent in *T. phlegyas* and *T. omphale*. On the other hand, neither the early wet-season form of *T. annæ* (1896), nor the early dry-season forms of several other species (1901) seem to have been affected by the application of moisture without the addition of heat, though a tendency towards the wet-season form made itself apparent under these conditions in *Pinacopteryx pigea* and, to a slighter extent, in *Crenis boisduvalii*.

7. Mr. Marshall has now detected constant differences in the respective larvæ and pupæ, which prove that *Byblia*

*götzius* (including *B. vulgaris*) is specifically distinct from *B. ilithyia*.

In conclusion, I wish to thank the authorities of the British Museum of Natural History, particularly Dr. Butler and Mr. Heron, for help that has always been courteously and readily given. My obligations to Professor Poulton are still more weighty; I owe to him the enjoyment of complete facilities for work in the Hope Department at Oxford, the loan of Mr. Marshall's letters, and the photographs of specimens that illustrate this paper. With regard to Mr. Marshall himself, I should wish to place on record my sense of the high value of his work as collector, experimenter and observer. He has had good opportunities, which he has known how to use in a thoroughly scientific manner. Moreover, what he has already achieved justifies us in looking for still greater results from his persevering labours.

## Explanation of Plate IV.

Fig. 1 (underside). *Byblia ilithyia*, Drury. A wet-season female.
2 (underside). Offspring of the above. An intermediate female, approaching the "dry" form which corresponds to the Indian *B. simplex*, Butl.
3 (underside). *Byblia götzius*, Herbst. A wet-season female, of the form *vulgaris*, Staud.
4 (underside). Offspring of the above. A dry-season male, of the form *acheloia*, Wallgrn.

(See pages 214, 215.)

5, 5*a* (underside). *Teracolus achine*, Cram. A wet-season female.
6, 6*a* (underside). Offspring of the above. A dry-season female of the form described by Trimen as *antevippe*, Boisd.
7, 7*a* (underside). *Teracolus omphale*, Godt. A wet-season female.
8, 8*a* (underside). Offspring of the above. A dry-season female, of the form described by Trimen as *theogone*, Boisd.

(See pages 210-211.)

9, 9*a* (underside). *Terias senegalensis*, Boisd. A wet-season female.
10, 10*a* (underside). Offspring of the above. A dry-season male, of the form *æthiopica*, Trimen.

(See page 215.)

In the actual specimens, owing to the presence of colour, the difference between the wet- and dry-season forms of the same species is more striking than appears in the Plate.

XII. *On the economic importance of the parasites of* Coccidæ. By Alice L. Embleton, B.Sc., 1851 Exhibition Science Research Scholar. Communicated by Dr. David Sharp, M.A., F.R.S., etc.

[Read April 16th, 1902.]

Of the numerous families of insects which possess great economic importance, it is generally admitted that there are none more deserving of attention than the *Coccidæ*—insects popularly known as "mealy bugs," "scales," and "bark lice." The enormous damage they do to plants of various kinds in all climates is effected by means of the long thread-like proboscis which is buried deeply in the host's tissue, and through which the sap is sucked.* They are excessively prolific, and their insignificant size, too, enables them only too easily to escape detection, the result being that many of them are becoming almost universally distributed. Add to this the fact that they are notoriously difficult to kill, and it is then easily comprehended that they are amongst the worst insect-pests the horticulturist has to reckon with. Not only are there immense numbers of individuals in a species, but also there are a great many species—the number already known has recently been computed at over a thousand.†

In spite of their undeniable importance as pests of a well-nigh ubiquitous character, they have received comparatively slight attention, with the result that the study of these creatures is but little advanced, being far in arrear of the state of knowledge in several other departments of Entomology. In this country in particular, the study of *Coccidæ* has been carried on by one or two naturalists; in America, especially during recent years, considerable interest has been taken in them and their economic aspects, for in that country it has been necessary to combat the

* Kochs [Jahrb. Hamb. Anst., xvii, 1900, Beiheft iii.] has recently studied the subject of the penetration of this proboscis into the plant tissues, and the effect its presence has on the host.

† "A check-list of the *Coccidæ*." T. D. A. Cockerell. Bull. Illinois Lab., iv, pp. 318–339.

very serious ravages of a variety of scales including the "pernicious," or San Jose scale (*Aspidiotus perniciosus*).

The history of the work done in this subject was summarized last year by Mr. R. Newstead,* and, in speaking of the contributions which have come from this country, he says: "Up to the year 1887 the English works were fragmentary and most inaccurate, but at that time Mr. J. W. Douglas began a series of articles on British and Foreign *Coccidæ*, in the "Entomologist's Monthly Magazine," which he continued till the year 1894, when he then completed his twenty-seventh article. Needless to add, these were very thorough, and contain a vast amount of valuable information to the student of the British *Coccidæ*." In 1891 Mr. Newstead began to publish his own work on the subject, and he has continued to do so up to the present time, the first volume of his monograph on British *Coccidæ* having only just been issued.

Although many of the species of *Coccidæ* have now been described and figured, our knowledge at present of the life-histories, parasites and all their varied biological aspects and relations is very limited; unfortunately, too, the knowledge that does exist is scattered and disconnected, so that it is of little help to the horticulturist, to whom the chief consideration is how to control these pests. For success in this matter it is of the first importance that the life-histories of the creatures should be thoroughly well known, and that the modes by which they are kept in check in a state of nature should be ascertained.

The insect enemies of scales are usually called "parasites"; but the term is ambiguous, for there are two distinct kinds: (i.) The predaceous enemies which roam about freely and devour the scales, and which it would be well to speak of as "predators"; (ii.) the true parasites, the best known of which are small Hymenopterous flies, whose growth and development take place inside the *Coccidæ*. In this way the pests may be actually exterminated, while at the same time there is little or no external evidence of what is occurring. The term "parasite" should be restricted to these internal destroyers.

The predaceous enemies of *Coccidæ* have received more attention than their internal parasites, and they have been

* "On the progress in the study of *Coccidæ*." Ent. Rec., xiii, 1901, pp. 57–59.

shown to be of enormous value, though their action is to some extent uncertain. But the internal parasites are less known, and, in fact, have been too much neglected, though a considerable amount of work has been done on them in recent years by Dr. L. O. Howard, Mr. Hubbard, and other able American Economic Entomologists. Mr. W. H. Ashmead has also published some valuable work on these parasites, including the "Classification of the old family *Chalcididæ*," * and a paper "On the genera of the Chalcid flies belonging to the sub-family *Encyrtinæ*." † In the latter work he gives the host, or hosts, of each species, which much enhances the importance and value of the paper.

A very interesting characteristic of some of these parasites is that they will attack more than one species of scale, which makes them especially valuable from the economic point of view. Information as to this may be found in Mr. Ashmead's second paper referred to above, but experiments are urgently needed to ascertain what parasites are likely to be most valuable on this account. Among those that attack more than one host, Ashmead mentions *Encyrtus infidus* Rossi, *Aphycus lecanii* Howard, *Blastothrix sericea* Dalman, *Microterys chalcostomus* Dalman, *M. fuscipennis* Dalman, *M. flavus* Howard, *M. sylvius* Dalman, *Arrhenophagus chionaspidis*, and *Signiphora flavopalliata* Ashmead, giving the hosts of each.

A case of considerable interest has lately been recorded by the Economic Entomologists, Köningsberger and Zimmerman, in their work on the enemies of coffee-culture in Java; they found that *Lecanium viride*, a highly injurious scale, is kept in check by the Hymenopterous parasite, *Encyrtus bogoriensis*. It is worthy of remark that this important and interesting relation has only been discovered within the last few years, and we may confidently anticipate that other parallel cases will soon be added to those already brought to light.

The fact that comparatively little is known about these parasites is scarcely a matter for surprise, for it must be remembered that the existence of these enemies is only obvious to the trained observer. A colony of scales may be thoroughly parasitized so that every individual is doomed, and yet to the unskilled eye there exists no

* P. Ent. Soc., Washington, iv, 3, pp. 242–249.
† P. U. S. Nat. Mus., xxii, pp. 323–412.

evidence that such is the case. This ignorance is often responsible for much harm that is done in the way of applying so-called remedies to exterminate the scale or mealy-bug; for, when the creature is already destroyed by the parasite, it is not only superfluous but highly injurious to apply insecticides or similar remedies, for these are then really destroying the beneficial insects which keep the scale in check.

Attention has lately been called to this important point * in the report of a discussion on the subject in America. Mr. Johnson "said that he had bred *Aphelinus fuscipennis* in great abundance from the San José scale this autumn. He is inclined to think that this parasite has become so abundant that it will be necessary to alter remedial measures against the scale. Instead of cutting down and burning at once, he will recommend girdling the trees and killing them, and then leaving them until all parasites have had a chance to escape before they are burned. He stated that he even doubts the wisdom of winter spraying, although he is not certain as to the stage in which the parasite hibernates." This discussion finally took the form of considering in what state these parasites of scales hibernate.

My own observations induce me to emphasize the importance of the remarks quoted above. As regards hibernation I can say that the parasite of *Lecanium hemisphæricum* var. *filicum* passes the winter in quite a variety of stages. Specimens of the perfect insect were observed in the act of emerging early last autumn, and they have continued to do so during the winter, except that emergence was interrupted by the very cold weather. During the winter I have examined and mounted a large number of the *Lecanium* and its parasite, and I have found all stages of the latter from half-grown larvæ to pupæ as well as adults ready for emergence, and waiting apparently only for a favourable moment. All the specimens that emerged in the autumn and winter were females, but in the last few days (March) the other sex has begun to appear. This *Lecanium* I have studied chiefly on ferns, but it occurs on other plants. King † says of this species: "*Lecanium hemisphæricum* Targioni Tozzetti, 1869. This is one of the commonest of scale insects found in greenhouses and on potted plants in dwelling-

* P. Ent. Soc., Washington, iv, part 4, July 1901, p. 413.

† "Greenhouse *Coccida*." Ent. News, Philad., xii, p. 311.

houses, especially on ferns; in the department greenhouses at Washington, D.C., it is found on the orange, *Drisipyrus, Chrysophyllus,* sago-palm, and *Croton variegatus;* on *Nephrolepis exultatus* and on *Cycas* in the College greenhouse at Colorado; on the house-fern and potted plants in New Mexico; on *Cycas revoluta* at Ames, Iowa; on two species of ferns at Warehouse Point, Conn.; on the sword-fern *Pteris,* sp., at Lawrence, Kansas; on ferns, palms, orange and oleander in Georgia; on *Arecha catecha* grown in pots in Jamaica; on *Cycas revoluta,* orange, oleander at Lawrence, Mass.; and on the fern *Nephrolepis tuberosa* at Cambridge, Mass. A common greenhouse pest in Europe, according to Signoret. It is found living out of doors in Europe and America." No mention, however, is made of any parasite.

This scale I find is parasitized to an enormous extent by a small Chalcid, viz. *Comys infelix,* n. sp.* On many of the same plants I also found another scale, *Chionaspis aspidistræ,* in great profusion, and I ascertained that it was parasitized by a very much smaller Chalcid, which may be *Aspidiotiphagus citrinus,* Howard, or more probably a form allied thereto. This insect has not, so far, been recorded in Britain, though it is possible it is in Walker's list under some name that has been unknown to the American Entomologists, who have done almost all the recent work on this subject. This is one of the smallest of insects, being scarcely visible to the naked eye (·35 m.m.), but its power of destroying the scale is enormous. On examining some of the badly infested plants I have noticed that scarcely any of the *Coccidæ* have escaped destruction by the Chalcid. Though the scales look perfectly natural, a minute round hole in each individual may be detected on close inspection. And yet the work of this microscopic

* This insect has been submitted to Dr. Howard, Mr. Cameron and Mr. Newstead, neither of whom is acquainted with it. It is closely allied to *Comys albitarsis* Zett., and *C. bicolor* Howard. The following diagnosis will be sufficient till I give a fuller description in the paper I am preparing on its life-history and structure.

*Comys infelix,* n. sp., Encyrtinarum. ♀ variegata, capite thoraceque fusco-aurantiacis, scutello nigro-hirto, abdomine nigro-subvioLaceo; pedorum coxis omnibus femoribusque anterioribus et intermediis albidis, femoribus versus apicem tibiisque fusco-flavis, his apicem versus laete flavis; tibiis posterioribus nigris; tarsis posterioribus albidis, basi apiceque nigro-maculatis; antennis scapo flavo, flagello nigro, flavo-maculato; alis anterioribus late nigro-signatis. Long. corp. 2 m.m., expans. alarum $3\frac{3}{4}$ m.m.

creature passes unobserved as the scales continue to adhere to the plant, and show to the unaided eye nothing to indicate that they are really exterminated. The question as to the distinguishing marks by which one may recognize scales that are parasitized is one of great interest, bearing as it does on the practical operations for controlling the diffusion of *Coccidæ*.

Returning to *Comys infelix*, the parasite of *Lecanium hemisphæricum*. During the latter stages of the development of the fly within the scale, it becomes evident from the outside which scales are parasitized and which have escaped attack. At first there is little or no difference in the scales; then it is noticed that those containing the larval fly look rather whitish and swollen. Later on as the pupa inside develops and becomes black, the scale can be seen to be swollen and black. In the fully-grown condition it is very evident when the fly is present, for the scale looks black instead of brown, due doubtless to the black pupa inside. The scale is more narrow and arched than in the normal condition. In the earlier stages it needs more experience before deciding which scales contain the parasites; those sheltering the large white larva look rather more pale and swollen than the others. In the very earliest stages it is almost impossible to detect the presence of the parasite by a superficial examination, but the larva, if present, is found on opening the scale. The mature forms of the scale usually exist on the same plant with the immature stages, and if these are seen to contain the parasite then it is fairly safe to deduce that the others are also attacked. Taking the average from a great many plants that I have examined, I find the proportion of scales destroyed by the parasite to be very high indeed, for usually almost every scale is killed. My experience is, of course, limited, and is relatively unimportant, for in order to make a reliable statement regarding the proportion of *Coccidæ* destroyed, many months would have to be devoted to collecting evidence and compiling statistics on this point, and my work has been mainly on other aspects of the subject. But as far as I can judge from the facts that have come under my immediate observation, I am led to rate very highly the value of these parasitic *Hymenoptera* as destroyers of Coccid pests. In the case of *Lecanium hemisphæricum*, King's statement that it is one of the commonest pests in greenhouses, applies to the neighbour-

hood of Cambridge as well as to the United States, and in the locality I refer to the pest is satisfactorily controlled by the parasite. If the parasite is not found in other localities where the scale is injurious it should be introduced there. Considerable difficulty has been experienced in the attempts to distribute the predaceous enemies, but in the case of the internal parasites, the task is much simpler, and success will be easier to attain, for it is only necessary to transmit a small plant bearing a few parasitized *Coccidæ*. From my work on this species of parasite I am led to believe that the *Encyrtinæ* are remarkably tenacious of life in their early stages.

Judging, therefore, from my own observations on the subject, supported as they are by Mr. Johnson's remarks quoted above, it is clear that, from the point of view of the cultivator, it is of the utmost importance that, previous to any attempt to destroy the *Coccidæ*, it should be ascertained whether internal parasites are present or not. If they are found in large porportion, then the application of a remedy should be abandoned. If they are present in a smaller proportion then time should be allowed before any insecticide be used, so that the parasites may emerge from all those individuals containing them, so as to allow the beneficial creature to be perpetuated and increased. After the emergence of the flies, then the *Coccidæ*, if any such there be, may be killed by using those insecticides which are especially adapted to the particular case.

An impression still seems to prevail in this country that the parasites of scales are of little importance from an economic point of view. Mr. F. V. Theobald,* in a report just issued, recommends the importation of Coccinellid predators to destroy scale, and then remarks: "A few minute *Ichneumonidæ* also feed on certain species of scales, but unfortunately our worst pests seem immune against them." By the term "*Ichneumonidæ*," doubtless Mr. Theobald is here referring to the *Chalcididæ*. It would be interesting to learn what efforts have been made in this country to ascertain how far "our worst pests seem immune against" Hymenopterous parasites. If the natural parasites have been found and their presence established, then experiments and trials ought to be carried on and the results published, and then one can judge more accurately as to the general question of economic importance of the Coccid parasites.

* Rep. South-Eastern Agric. Coll., Wye; March 1902.

Abroad, however, and particularly in the United States, this problem of the natural enemies of insect-pests is receiving attention and careful study. In a paper * just come to hand, Mr. H. Maxwell-Lefroy remarks that, beyond useful birds and other animals, "there are the hosts of predaceous and parasitic insects of whose work it is difficult to form any conception. Little can be done to encourage these beyond taking reasonable precautions that our preventive or remedial measures do not destroy them, and spreading such a knowledge of them as will prevent their destruction through ignorance as pests."

It is very satisfactory to find from such notes as this and that of Mr. Johnson, that Economic Entomologists are recognizing that their operations must not be confined to mere destruction; and that to be of permanent value they must be based on a reliable knowledge of the natural history of the pests.

In connection with this it may be remarked that a knowledge of the natural modes of dissemination of both the pests and their parasites is essential in the work which is carried on in various parts of the world to prevent the introduction of pests, and often spoken of as quarantine. These regulations exist in Austria-Hungary, Belgium, France, Germany, Canada, British Columbia, Cape of Good Hope and elsewhere, though not in Britain.

It is indeed difficult to understand how insects that are not only apterous but which have, in many cases, even lost their legs, become so widely distributed, or even how they succeed in spreading from tree to tree. All *Coccidæ*, however, have the power of walking when newly hatched. I have watched the active young of several species—*Lecanium*, various spp., and *Pulvinaria camellicola*—and I found that they wandered restlessly about on the plant, and in a very short time I noticed they were migrating from the plant, so that out of the myriads which appeared only a few remained on the host plant. These, however, are quite sufficient to carry on the destruction of that plant, though the majority wander off in search of new hosts. I carried on experiments in this matter on scales on camellia and rose-plants, grape vines, ferns, and other plants, and the result was always that the majority of the young wandered away in spite of all obstacles. It is known that considerable

* "Suggestions for Insect Control in the West Indies." West Indian Bull., ii, No. 4, pp. 318–344.

variety of behaviour prevails among the young of different species; but as far as I can judge from the facts which came under my notice and from previous observations, it seems that all the forms are very tenacious of life when young; I found them wandering for days over the shelves of the hot-house in which I was rearing them.

*Lecanium hemisphæricum* is noted for its unusual powers of locomotion. Signoret * speaking of this Coccid says: "Cette conformation des tarses indiquerait peut-être que les espèces de cette série sont moins fixes que leurs congénères." Comstock† confirms this by the statement that "actual observation shows the surmise of Signoret as to the locomotive powers of the insect to have been correct. We have seen the adult insects, when removed from their positions, crawl back with apparent ease." I have seen this happen repeatedly. Reh ‡ made experiments and found that certain young Coccids could move a metre in about an hour. But he thinks, and I agree with him, that it is improbable that their own powers of locomotion are the most important means by which they become distributed. The most valuable information on this point is to be found in some briefly-described observations by Hubbard. I cannot do better than quote some passages from this talented and lamented American observer.§ "During the migratory age the restless habit of the young bark-lice impels them to crawl actively about, turning aside for no obstacles, but mounting every object met with in their path. The instinct of self-protection being entirely wanting in these degraded creatures, they make no distinction between dead and living objects, and crawl without hesitation upon the bodies of other and larger insects. The latter, impelled by the annoying presence of the intruders, fly away, bearing with them the scale larvæ, and thus assist in distributing them upon surrounding plants. . . . But spiders more than any other animals must be considered efficient instruments in this mischievous work. Not only do they transport the lice—and it is an observed fact that the movements of the latter upon their hairy backs do not incommode the spiders—but they also

* "Essai sur les Cochenilles ou gallinsectes (Homoptères-Coccides)," Ann. Soc. Ent. France (5), iii, 1873, p. 437.

† "Report of the Commissioner of Agriculture for 1880," p. 334.

‡ Jahrb. Hamb. Wiss. Anhalten, xvii, 1899; 3 Beiheft, pp. 1–6.

§ Amer. Natural, xvi, 1882, p. 411.

harbour them under their webs in folded leaves, etc., where, safe from the attacks of parasites and enemies, they increase and multiply inordinately." He thinks the popular theory that wind carries scale insects from tree to tree is fallacious to a great extent, but that there is an indirect action of the wind, due to the influence it exerts upon the flight of insects and other winged animals which transport *Coccidæ;* this applies with particular force to spiders whose webs are carried in the direction of prevailing winds.

Hubbard's brief observation in his paper on "Insects affecting the Orange," suggested the experiments connected with insects and spiders conveying the pest, which I carried on last year with Mr. C. Warburton, as to the modes of dissemination of the black-currant gall-mite (*Eriophyes* [*Phytoptus*] *ribis*).* Here it was found that spiders, Aphidæ, Coccinellid larvæ, and, indeed, any passing creature, carried the mites in considerable numbers from bush to bush.

Thus it appears probable that, in a state of nature, *Coccidæ* are largely disseminated by the agency of other insects. The males are active on the wing, and if a single female were transported by an insect to another tree, a new colony would in this way soon be established. This mode of dissemination, and the observations I have related as to the crawling of the young on inanimate objects, are clearly of considerable significance in connection with the quarantine operations that I have referred to as being carried out in different parts of the world. For the creatures may be imported on merchandise or by insects as well as on plants. Neither should it be forgotten, that if a pernicious scale be once introduced and then all other importations be prevented, then the parasites that may be contained in the scales are excluded. To avoid this, a knowledge of the marks by which parasitized scales can be distinguished from others, is really essential in the carrying out of the quarantine regulations.

Fortunately for the prospects of the cultivator, it sometimes happens that in places where noxious insects have been introduced, some native insect may be ready to take up the work of control that is performed by other destroyers in the original country. Marlatt † in his recent

* Linn. Soc., London, xxviii, pp. 366–378, pls. 33, 34.

† Proceedings of the Thirteenth Annual Meeting of the Association of Economic Entomologists, 1902, p. 45.

report on the San José scale in Japan, after stating that this Coccid has been lately established in that country, says, "the scale is attacked also by one or two Chalcid parasites, presumably the ones we have in America, and brought to Japan with the scales or cosmopolites." It is very probable that the pernicious scale is really a native of Japan,* and that this is the reason why it is not injurious there; scale insects are very rarely destructive in their natural homes because of the natural relations that exist between them and their destroyers. Sasaki † says the principal enemies of *Aspidiotus perniciosus* are a red mite, *Coccinella japonica*, and a Chalcid fly (? *Coccophagus*). He states that "in the specimens of the scale allied to the pernicious scales collected by myself, I have often found a roundish, or rather small irregular opening in most of the scales, which is evidently perforated by the parasitic Chalcid fly" (p. 172).

My object in writing this paper is not merely to add a few items to the facts of Economic Zoology, but rather to point out how very much remains to be discovered, even as to matters that have a very serious economic bearing. This is a somewhat invidious task, for it seems to involve a reflection on those who have worked at the subject. I should like to say that I hope no inference of that kind will be drawn from anything I have said. The work done by many Economic Entomologists is admirable, and the American school has accomplished wonders; and in nothing are they more worthy of admiration than in their readiness to modify their methods in accordance with the advance of knowledge.

It is encouraging to find how clearly it is being recognized that the chief consideration of the Economic Entomologist should not be the mere prescription of modes of destruction, but should be rather in the direction of learning the facts of the natural history of the pests. It may be predicted that the Economic Zoology of the future will be generally recognized as being "Applied Natural History." The prevention of the undue increase of enemies should therefore be the object of the economic investigator, so that wholesale destruction of life should be rarely, if ever, required.

* See Marlatt and others in Bull. U.S. Dep. Agric. Ent., xxxi, 1902, pp. 41–48.

† Annot. Zool. Japan, iii, p. 171.

XIII. *Additional Notes on Mr. Distant's Collection of African* Locustidæ. By William F. Kirby, F.L.S., F.E.S.

[Read April 16th, 1902.]

In my former paper (*antea*, pp. 57–114) I was unable, through illness, to include a few species, chiefly belonging to the genus *Acrotylus*, Fieber, which had been set out shortly before the paper was read; and I have also to add some localities, etc. 16 species are added to the former list in the present paper, half of which are described as new, 5 of these being species of *Acrotylus*. This brings up the total number of species to 141; including 2 new genera and 41 new species. For convenience of reference, I have cited the page on which each genus will be found in the first paper.

*TRYXALIDÆ.*

Genus Acrida, Linn. (p. 61).

11. *Acrida gigantea*, Fuessly.

*Hab.* Transvaal: Johannesburg (*A. Ross*).

Genus Phlæoba, Stål (p. 65).

22. *Phlæoba interlineata*, Walker.

*Hab.* Transvaal: Johannesburg (*A. Ross*).

Genus Pnorisa, Stål (p. 67).

27. *Pnorisa squalus*, Stål.

*Hab.* Transvaal: Johannesburg (*A. Ross*).

Genus Epacromia.

*Epacromia*, Fischer, Orth. Eur., p. 360 (1853).

29a. *Epacromia thalassina.*

*Gryllus thalassinus*, Fabricius, Spec. Ins., i, p. 367, n. 31 (1781).
*Epacromia thalassina*, Brunner, Prodr. Eur. Orth., p. 146 (1882).

*Hab.* Transvaal: Eureka, Barberton (*Rendall*); Natal (*Distant*).

A common species in South Europe, Africa, and many parts of Asia.

Genus Chortoicetes, Brunner (p. 69).

30. *Chortoicetes prasina*, Walker.

*Hab.* Transvaal: Johannesburg (*A. Ross*); Delagoa Bay (*Distant*); Nyasaland: Fort Johnston (*Rendall*).

31a. *Chortoicetes interruptus*, sp. n.

Long. corp. 20–22 millim.; exp. al. 41–44 millim.

Head reddish-brown, antennæ red, a long reddish stripe below each eye, pointed at the lower end, and another running from the back of each eye over the pronotum, divided by four oblique lines, which do not cross; cheeks with an oblique yellowish line between two black marks; abdomen greenish-brown, legs testaceous, hind femora above with transverse black bands, outer area blackish, irregularly marked with pale yellow; inner area black, interrupted by a pale yellow blotch before the extremity. Tegmina rufo-testaceous, subhyaline towards the tips, and with a longitudinal greenish stripe above and parallel to the inner margin, a row of three or four brown spots, sharply defined, and mostly oval or oblong, on the basal half of the tegmina, intersected by the principal nervure; beyond these, are several rounder spots, below the nervure. Wings pale greenish hyaline at the base, followed by a rather broad curved blackish band, extending to the hind margin, but distinctly interrupted below the costa; apical area outside the band clear hyaline.

*Hab.* Transvaal: Pretoria (*Distant*).

Allied to *C. plena*, Walker, but in addition to the characters above given, the vertex is more pointed in front, and much narrowed above the eyes.

*LOCUSTIDÆ.*

Genus HUMBE.

*Humbe*, Bolivar, J. Sci. Lisb., xxx, p. 117 (1882).
*Humbella*, Saussure, Mém. Soc. Genève, xxviii (9), pp. 50, 105 (1884); xxx (1), pp. 17, 32 (1888).

34A. *Humbe tenuicornis.*

*Pachytylus tenuicornis*, Schaum, Monatsb. Akad. Berlin, 1853, p. 779; Peters' Reise Mossamb. Zool., v, p. 137, pl. vii A, f. 6 (1862).
*Humbella tenuicornis*, Saussure, Mém. Soc. Genève, xxviii (9), p. 106 (1884).
*Pachytylus* (*Œdaleus*) *punctifrons*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 50 (1876).

*Hab.* TRANSVAAL: Pretoria (*Distant*).
A widely-distributed species in East, West, and South Africa.

Genus GASTRIMARGUS, Saussure (p. 71).

37B. *Gastrimargus vitripennis.*

*Œdaleus vitripennis*, Saussure, Mém. Soc. Genève, xxx (i), p. 38 (1888).

*Hab.* TRANSVAAL: Pretoria (*Distant*).
A widely-distributed species in South and Central Africa, and distinguished by the absence of any dark band on the hind wings.

Genus HETEROPTERNIS, Stål (p. 75).

Page 75, no. 42, line 4 from bottom, for *Heteropternis pudica*, Saussure, read *H. pudica*, Serville.

Genus ACROTYLUS, Fieber (p. 76).

45. *Acrotylus femoralis*, sp. n.

Long. corp. 20–32 millim.; exp. al. 36–48 millim.

Head and pronotum yellowish-grey, vertex, and some large granulations on the front of the pronotum blackish; tegmina long, narrow, and pointed, the central area densely reticulated with reddish-brown, the cells between subhyaline towards the borders; the central

area with complete intercalated nervures. Wings pink, with only the extreme borders brownish subhyaline. Antennæ wanting, legs and pectus very hairy, four front legs yellowish-grey, hind femora with the outer area yellowish-grey dotted with black, the inner area black nearly to the extremity, where a yellow ring separates it from the knee, which is red, bordered with black above and at the side ; lower part of femora red. The black stripe on the inside of the femora is marked rather beyond the middle by a double longitudinal row of yellow dots, about four in each row. Hind tibiæ and tarsi yellow on the outside, and red on the inside ; tibiæ inside with a black stripe, followed by a yellow ring.

*Hab.* TRANSVAAL: Pretoria (*Zurtz*).

Described from two damaged specimens. Probably allied to *A. crassus*, Saussure.

45a. *Acrotylus zonatus*, sp. n.

Long. corp. 15 millim. ; exp. al. 34 millim.

Head and thorax brown, rugose and granulated, back of the head varied with black and yellow, antennæ not longer than the head and pronotum, and tipped with black, abdomen yellow, with black blotches on the back and sides, and three rows of black dots below ; last ventral segment black and shining ; four front legs belted alternately with black and yellow, hind femora yellowish on the outside ; black on the inside and on the inner sulcus beneath ; on the inside it is interrupted by a yellow band below the knee, preceded by some detached yellow markings ; hind tibiæ black, with a tawny belt near the base ; hind tarsi tawny. Tegmina rusty brown, with intercalated nervures, and intermediate longitudinal series of brown dots and dashes ; two large brown marks, extending nearly across, one at the convexity on the costa near the base, and the other beyond ; round the borders are also brown spots alternately with light ones. Wings with the base and inner margin pink ; a very broad curved smoky brown band, widening to, and expanding on the costa to the base, but not extending below to the inner margin ; and the hind margin subhyaline.

*Hab.* TRANSVAAL: Pretoria (*Distant*).

*A. zonatus* agrees with *A. concinnus*, Serville, in the great extent of the brown band on the hind wings, which separates both species from *A. hottentottus*, Saussure ; but *A. concinnus* is described as having the hind femora yellow on the inside.

### 45B. *Acrotylus annulatus.*

Long. corp. 16–18 millim. ; exp. al. 36–42 millim.

Head and thorax rugose and granulated, rufo-testaceous, abdomen reddish, with black markings on the back towards the base, and yellow markings on the sides. Legs reddish, four front legs annulated with brown, hind femora indistinctly spotted with black outside, and black on the inside, with two yellow bands before the extremity, hind tibiæ black, with two broad yellow rings, the second broadest, spines black, eight in the outer row, tarsi yellow. Tegmina rosy brown, subhyaline towards the extremity, with numerous intercalated nervures, marked with two large brown shades on the costa, one on the convexity, and the other beyond, and with numerous other smaller indistinct brown and pale spots chiefly along the borders ; between the principal longitudinal nervures runs a series of small long or round brown dots. Wings subhyaline, with the base yellow, and the hind margin very broadly infuscated.

*Hab.* TRANSVAAL: Pretoria (*Distant*); NATAL: Durban (*Ross*).

Described from five specimens. But for the intercalated nervures, I should have referred this species to *A. apricornis*, Stál ; but this is placed by Stal and Saussure in the other section of the genus. From *A. deustus*, Stál and Saussure (and Thunberg ?), *A. annulatus* is separated by the colour of the legs.

### 45C. *Acrotylus patruelis.*

*Gryllus patruelis*, Herrich-Schäffer, Panzer, Faun. Germ. Fasc., 157, pl. xviii (1840).

*Acrotylus patruelis*, Brunn. Prodr. Eur. Orth., p. 156 (1882); Sauss., Mém. Soc. Genève, xxviii (9), p. 191 (1884); xxx, p. 68 (1888).

*Œdipoda inficita*, Walker, Cat. Derm. Salt., B. M., iv, p. 742, n. 75 (1870).

*Hab.* TRANSVAAL: Pretoria (*Distant*); NYASALAND: Fort Johnston (*Rendall*).

A widely-distributed species occurring throughout South Europe, Africa, and Western and Southern Asia eastwards to Ceylon. It is very variable, and the specimen from Pretoria much resembles Walker's types of his *Œ. inficita*, and labelled "Sandwich Islands. Presented by Captain Beechey"; but they are probably from the Canaries, like

some other *Orthoptera* in the British Museum bearing the same label.

### 45D. *Acrotylus furcifer.*

*Acrotylus furcifer*, Saussure, Mém. Soc. Genève, xxx (i), p. 69 (1888).

*Hab.* TRANSVAAL: Barberton (*Rendall*).

A single specimen, which I refer to this species with some hesitation, as the description is not sufficiently precise.

### 45E. *Acrotylus flavescens.*

*Acrotylus flavescens*, Stål, Rec. Orth., i, p. 135 (1873).
*Acrotylus angulatus*, Stål, Œfv. Vet. Akad. Förh., xxxiii (3), p. 52 (1876); Saussure, Mém. Soc. Genève, xxxviii (9), p. 189, n. 5 (1884).

*Hab.* TRANSVAAL: Pretoria (*Distant*); Ovambo (*angulatus*, Stål); CAPE; CHINA (*flavescens*, Stål).

About 40 specimens. The insect appears to be both very abundant and very local. In one or two specimens the head and thorax are reddish, with the characteristic black markings more or less obliterated.

The two names referred to above appear to me to relate to the same species.

### 45F. *Acrotylus saltator*, sp. n.

Long. corp. 15 millim.; exp. al. 44 millim.

Head and thorax brown above, yellow on the sides, with a black triangular mark expanding behind each eye, and meeting on the back at the principal suture; below it another black mark curves back from the middle of the cheek to the principal suture; hind lobe of pronotum brown, punctured. Intercalary spaces, pectus, and basal half of abdomen above mostly black; abdomen beneath and at the sides yellow; four front legs yellow, indistinctly banded with brown; hind femora yellow on the outside; and above, but with two black transverse bands above, before the knees, which are black, inside and undersurface black, a yellow band before the knee on the inside; hind tibiæ black in the middle, with a yellow band near the base, and the apical fourth red; spines black, nine in the outer row; tarsi red. Tegmina with intercalated nervures, brown, with a quadrate whitish spot near the costa beyond the convexity, and some irregular

scattered whitish spots elsewhere ; wings subhyaline, pale blue, with the apical third brown, the colour diminishing towards the anal angle.

*Hab.* Delagoa Bay (*Junod*).

### 45g. *Acrotylus gillettæ*, sp. n.

Long. corp. 18 millim. ; exp. al. 33 millim.

Tegmina narrow, longer than the wings, rosy grey towards the base, subhyaline on the costa beyond the convexity, and over the outer half of the tegmina, except along the anal area. A row of seven black costal spots, the first five large, the 3rd and 4th not quite touching the costa, the 6th and 7th much smaller, and annular ; there is also a series of smaller brown spots on the inner margin, but receding from it towards the base, and there are also numerous blackish and brown dots towards the base and middle of the tegmina. Wings clear hyaline, the nervures blackish, with some of the intermediate longitudinal nervures pale ; the pale nervure marking the uppermost fold is ornamented towards its extremity with a few brown spots on each side. Pronotum, antennæ, and thorax rosy grey, cheeks whitish, the principal suture on the pronotum is marked with four yellow callosities, two on the back, and two on the sides, a black spot at the base of the wings ; otherwise the intercalary space is rosy grey in the middle, and bluish-grey on the sides ; abdomen testaceous, with two large and transverse bluish spots at the base, bordered above with black. Two front legs rosy grey, indistinctly spotted with brown ; hind femora whitish on the outside, and yellowish-white on the inside, irregularly streaked and spotted with brown ; hind tibiæ pale blue in the middle, yellowish towards the base, and reddish towards the extremity ; tibial spines black, seven in the outer row ; terminal spines very long, reddish, tipped with black.

*Hab.* Nyasaland : Fort Johnston (*Rendall*) ; Somaliland (*Miss F. Gillett*).

Closely allied to *A. quadrimaculatus*, De Haan, which Stål and Saussure place as a synonym of *A. deustus*, Thunberg. Apart from the identification of Thunberg's insect being very doubtful, *A. quadrimaculatus* and *gillettæ* have no intercalated nervures on the forewings, and therefore belong to a different section to that in which Stal and Saussure have placed their *A. deustus*. *A. quadrimaculatus* and *A. gillettæ* seem to form a transition between *Acrotylus* and *Sphingonotus*.

## CYRTACANTHACRIDÆ.

### *CYRTACANTHACRINÆ.*

Genus CYRTACANTHACRIS, Walker (p. 102).

102. *Cyrtacanthacris variegata*, Walker.

*Hab.* TRANSVAAL: Johannesburg (*A. Ross*).

### *CATANTOPINÆ.*

Genus COPTACRA.

*Coptacra*, Stål, Rec. Orth., i, pp. 37, 58 (1877).

108A. *Coptacra paupercula*, sp. n.

Long. corp. 12–15 millim. ; exp. al. 27–31 millim.

Head, pronotum, and tegmina reddish-brown, thickly dusted with grey ; head and pronotum thickly and closely punctured, frontal ridge very broad above between the antennæ, narrower below, hinder orbits narrowly whitish ; antennæ red ; in one specimen the sides of the pronotum are blackish, bordered below with a large subtriangular whitish spot ; wings pale yellow, subhyaline ; four front legs brownish on the outside, and more or less grey on the inside ; hind femora whitish above, with two or three transverse blackish bands ; outer surface wholly whitish, inner surface wholly red ; the sulcus below the white outer area black ; tibiæ and tarsi red, tibial spines tipped with black, eight spines on the outer carina, basal joint of tarsi as long as the third, and considerably expanded.

*Hab.* TRANSVAAL, Pretoria ; Warm Baths, Waterberg, (*Distant*).

Allied to *C. succinea*, Krauss, but does not quite agree with the description.

Described from two specimens.

Genus ACRIDODERES.

*Acridoderes*, Bolivar, J. Sci. Lisb. (2), i, p. 163 (1890).

108B. *Acridoderes crassus.*

*Acridoderes crassus*, Bolivar, l. c. (1890).

*Hab.* TRANSVAAL: Pretoria (*Distant*); FWAMBO (B. M.); CACONDA, QUANGO (*Bolivar*).

A single specimen only from Pretoria.

108c. *Acridoderes punctatus*, sp. n.

Long. corp. 30 millim. ; exp. al. 73 millim.

*Female.* Rufo-testaceous, with traces of bright red markings ; a series of irregular white markings extending nearly round the eyes, but especially below, and below these, is a very oblique white streak. Pronotum with very large depressed punctures, and with numerous black spots, interspersed on the sides with some white ones. Hinder lobe granulated and rugose-punctate, slightly produced and truncated behind, and with the terminal carina marked with three black spots on each side. Cerci slender, hooked inwards at the end, subgenital lamina produced into a long broad-pointed keel considerably beyond the abdomen. Legs probably red during life ; four front legs with the joints slightly marked with black ; middle femora indistinctly spotted with black ; hind femora strongly spotted with black on the upper and outer carinæ ; upper surface with traces of two black transverse bands ; outer median area with a double row of broad opposing white stripes ; hind knees marked with black ; spines of hind tibiæ whitish, tipped with black, and spotted with black at the base, six or seven on the outer carina. Prosternal tubercle rather large and rounded. Tegmina subhyaline, very thickly reticulated, the principal longitudinal nervures more or less black, and the rest of the neuration reddish ; costal area with indistinct brown spots, the rest of the wing marked with irregular double transverse brown lines, rather far apart, and brown rings, etc. Wings greenish hyaline, with brown neuration, and the tips clouded with brown.

*Hab.* Transvaal: Rustenburg (*Distant*).

But for the much smaller size of this specimen (especially considering that it is a female), the much narrower wings, more obtuse pronotum, and the broader rounded prosternal spine, which resembles that of *Catantops*, I should have been inclined to refer it to *A. crassus*, Bol. *A. punctatus* has much superficial resemblance to some of Walker's species which I include provisionally in *Catantops*, such as *Acridium adustum* and *Cyrtacanthacris spissa* of Walker. I should add that the shape of the prosternal tubercle is probably a less important character in *Locustidæ* than has been imagined.

Genus Catantops, Schaum (p. 105).

112. *Catantops decorata*, Gerstaecker.

*Hab.* Transvaal : Johannesburg (*A. Ross*).

Genus STENOCROBYLUS, Gerstaecker (p. 108).

115. *Stenocrobylus trifasciatus*, Kirb.

*Hab.* NYASALAND: Fort Johnston (*Rendall*).
Wings pale red, grey towards the costa and tip.

*CALLIPTAMINÆ.*

Genus EURYPHYMUS, Stål (p. 109).

117. *Euryphymus erythropus*, Thunberg.

*Hab.* TRANSVAAL: Johannesburg (*A. Ross*).
A very small specimen.

117A. *Euryphymus vylderi.*

*Euryphymus vylderi*, Stal, Efvers. Vet. Akad. Förh., xxxiii (3), p. 42 (1876).

*Hab.* TRANSVAAL: Barberton (*Rendall*); DAMARALAND (*Stål*).
I am not quite certain whether I have identified this species correctly.

Genus CALLIPTAMUS, Serville (p. 109).

118A. *Calliptamus semiroseus.*

*Calliptamus semiroseus*, Serville, Ins. Orth., p. 692 (1839).

*Hab.* TRANSVAAL: Pretoria (*Distant*).
A single female specimen, which appears to be referable to this species. It is remarkable for the unusually short tegmina.

118B. *Calliptamus minor.*

*Caloptenus minor*, Walker, Cat. Derm. Salt., iv, p. 699, n. 48 (1870).

*Hab.* TRANSVAAL: Pretoria (*Distant*), Zoutpansberg (*Kaessner*).
Both these specimens are females, and differ from the type, which is a male, by the somewhat shorter and broader pronotum, and the markings of the wings, which are subhyaline, brown at the base and along the inner margin,

with a longitudinal row of long brown spots in the discoidal cell, a large brown spot at the end of the cell, and several between this and the apex; but not symmetrical on the two sides. The male has large reticulated brown spots extending over the outer half of the tegmina. *C. semiroseus*, var. (?) Walker (*nec* Serville), appears to be a variety of *C. minor* in which the wings are tinged with rose-colour at the anal angle; in the type of *C. minor*, and in the two females here referred to that species, the wings are clear hyaline, without any tinge of rose-colour.

119. *Calliptamus tibialis*, Kirb.

*Hab.* TRANSVAAL: Johannesburg (*A. Ross*).

# XIV. *Memoir upon the Rhynchotal family* Capsidæ *Auctt.*

By George Willis Kirkaldy, F.E.S.

[Read December 4th, 1901.]

Plates V and VI.

Thanks to the gigantic labours of F. X. Fieber and O. M. Reuter, we have now a considerable knowledge of the external morphology of the palæarctic forms, except those inhabiting Japan and North-Eastern China. Good work has also been effected upon the American fauna, and we have at least a general acquaintance with the dominant forms of the regions comprised. But of the Oriental, Australian, and Ethiopian regions, there is only very scattered and imperfect information, and it is a matter of some little difficulty to present comprehensible descriptions of new genera and species from them, as these are often isolated, with little affinity to the forms of other regions, as for example *Platyngomiris corcoides* and *Bothriomiris marmoratus* now described. The great divisions instituted by Reuter for the palæarctic fauna, and very largely adoptable for North America, are often inadequate for the other regions; his Miraria for instance seem not to be so sharply separable from his Capsaria in some extra-European genera. The number of cells in the membrane moreover is a character not I think to be too rigidly enforced; for *Platyngomiris* is in its general structure undoubtedly a "Capsarian," but has only one cell, while some at least of the numerous genera now embraced by the "Bryocoraria" appear to me to have little affinity with *Bryocoris*, Fallén.

I have recently had the good fortune of acquiring his exotic collection of this family, from my friend Mr. A. L. Montandon. I have also received some Indian material from my friend Mr. Gerald C. Dudgeon, from which two new genera and species are now described. The rest are all from Mr. Montandon's collection, and are but a small proportion of it, as only the more remarkable forms have been selected. The types are all in my own collection.

Unless otherwise stated, the "length" of a bug is taken

from the apex of the head as seen from above, to the apex of the elytra when at rest.

The forms noticed in this memoir are geographically distributed as follows. New genera and species are denoted by an asterisk.

### Palæarctic Region.

21 *Olympiocapsus,* cælestialium.**
42 *Megaloceræa*, Fieber, *cælestialium.**

### Oriental Region.

4 *Systellonotus*, Fieber, *palpator.**
6 *Helcista,* laudator.**
8 *Berta*, Kirkaldy, *lankanus* (Kirby).
17 *Kosmiomiris,* rubroornatus.**
18 *Hyalopeplus*, Stål, *lineifer* (Walker).
19 *Malacopeplus,* discoidalis* (Walker).
23 *Eblis,* amasis.**
24 *Kangra,* dudgeoni.**
25 *Platyngomiris,* coreoides.**
26 *Cheilocapsus,* flavomarginatus.**
30 *Eurystylus*, Stål, *costalis* (Stål).
31 *Deræocoris*, Kirschbaum, *sacratus.**
33 *Tinginotum,* javanum.**
34 *Disphinctus*, Stål, *sumatrator.**
35 *Disphinctus*, Stål, *anadyomene.**
41 *Helopeltis*, Signoret, *insularis.**
48 *Rhinomiris,* vicarius* (Walker).
50 *Bothriomiris,* marmoratus.**

### Ethiopian Region.

2 *Diocoris,* agelastus.**
3 *Nesidiocoris,* volucer.**
5 *Sphinctothorax*, Stål, *montandoni.**
20 *Umslopogas,* nigroquadristriatus.**
22 *Zulaimena,* hathor.**
28 *Korasiocapsus,* pylaon.**
29 *Proboscidocoris*, Reuter, *scti.**
32 *Lygus*, Hahn, *osiris.**
44 *Helopeltis*, Signoret, *waterhousei.**

### Australian Region.

1 *Orthotylus*, Fieber, *eurynome*.*
27 *Eurybrochis*,* *zanna*.*
45 *Eurymiris*,* *eurynome*.*
46 *Austromiris*,* *viridissimus*.*
47 *Saturniomiris*,* *tristis* (Walker).
49 *Zanessa*,* *rubrovariegata*.*

### American Regions.

7 *Orectoderus*, Uhler, *obliquus*, Uhler.
9 *Hesperolabops*,* *gelastops*.*
10 *Sysinus*, Distant, *floridulus*, Distant.
11 *Neofurius*, Distant, *aurora*.*
12 *Resthenia*, Spinola, *scutata*, Spinola.
13 *R. simulacrum*.*
14 *R. berta*.*
15 *Lomatopleura*, Reuter, *hesperus*.*
16 *Neurocolpus*, Uhler, *nubilus* (Say).
36 *Monalonion*, Herrich Schäffer, *atratum*, Distant.
37 *M. xanthophilus* (Walker).
38 *M. pilosipes*.*
39 *M. megiston*.*
43 *Eioneus*, Distant, *bilineatus*, Distant.
44 *Collaria*, Provancher, *oleosus* (Distant).

A total of 22 new genera and 36 new species.

#### 1. *Orthotylus eurynome*, sp. nov.

♂ ♀ macropterous, concolorous; above with sparse black hairs, not mixed with white hairs. General colour dark green, anterior part of pronotum, scutellum and legs dilute. Elytra saturated, opaque. Eyes dark greyish-green; antennæ pale sordid greenish-brown; tarsi brownish. Membrane subhyaline, fumate, immaculate, cells concolorous, nervures after death flavescent. Vertex wider than an eye, longitudinally impressed. Second segment of antennæ 4 times as long as 1st which is $\frac{3}{5}$ of the length of the pronotum. Rostrum scarcely reaching beyond intermediate coxæ. Pronotum obscurely marginate laterally. Posterior tibiæ more than 4 times as long as tarsi, 2nd tarsal segment subequal to the 3rd.

Long. 5 mill., lat. 1¼ mill.

*Hab.* Australia, Victoria, Alexandra.

Allied to *O. virescens*, Douglas and Scott, Reuter.

The genus *Orthotylus* has a wide range, viz., the whole palæarctic region (except Japan and China), New Guinea, Australia, St. Helena, Hawaiian Group and North America, and is doubtless even still more widely extended.

### *Diocoris*, gen. nov.

Closely allied to *Lamnocoris*, Reuter, but with longer head, eyes very long, pronotum not strongly narrowed anteriorly. Female macropterous with unialbosignate elytra.

Elongate; head almost vertical, elongate, $\frac{2}{3}$ longer than high, acutangular apically (profile). Vertex broad, nearly 3 times as wide as an eye, acutely triangular in front of the eyes (vertical), base finely but distinctly sinuately marginate; antennæ about as long as entire body. Eyes quite half the length of head (seen in profile), distinctly sinuate laterally, contiguous with pronotum, extending laterally farther than anterior lobe of pronotum. Rostrum reaching a little beyond base of posterior coxae, first segment not reaching to base of head, three apical subequal in length to one another. Pronotum declivous, anteriorly not strongly narrowed, lateral margins of anterior half parallel, posterior half not greatly divergent, base conversely sinuate, exposing anterior part of scutellum, about $\frac{5}{8}$ wider than apical margin (of pronotum); pronotum about 3 times as long as the eye (as seen from above). Collar distinctly separated from pronotum by a very narrow suture, but not at all constricted. Elytra reaching beyond apex of abdomen, sinuately emarginate laterally, unialbosignate; cuneus not (or scarcely) declivous. ♀ macropterous. Abdomen strongly constricted at the base.

#### 2. *D. aglastus*, sp. nov.

Covered with exceedingly short close velvety pubescence of the general ground colour, not long pilose, punctured nor rugose. Very dark chocolate with a purple tint (a little browner on vertex), pronotum and scutellum purplish-black. Antennæ dark brown, apical 2 segments covered with dense pale pubescence. Eyes stramineous. A central transverse band on corium, narrowing on entering the clavus, which it traverses (also lateral margins of elytra very narrowly)—whitish. Membrane dark fumate, semiopaque, nervures brownish-black. Pronotum about $2\frac{1}{2}$ times as long as 1st segment of antennæ, which is about half the length of the head (profile); 2nd segment nearly 3 times as long as 1st ($\frac{2}{5}$ longer than pronotum), subequal to the 3rd, which is $\frac{3}{4}$ longer than the 4th.

Long. 5 mill.

*Hab.* Guinea, Addah.

From the appearance of a macropterous ♀, it is highly probable that there exists an antlike ♀ form.

### *Nesidiocoris*, gen. nov.

Closely allied to *Campyloneura*, Fieber, but easily distinguishable by the much larger eyes, narrower vertex (looking more like some of the Pilophoraria of Reuter) and the longer legs.

Vertex convexly rounded, declivous, a little narrower (at the narrowest part) than the large, internally convexly-rounded eyes which occupy almost the whole space (longitudinally) from base of head to antennæ. Vertex somewhat feebly marginate at base. Rostrum reaching a little beyond apex of intermediate coxæ, 1st segment reaching a trifle beyond base of head. Collar and callosities well-marked. Pronotum a trifle more than twice as long as an eye, lateral margins concavely sinuate, postero-lateral angles prominent; base emarginate, twice as broad as head. Interior nervure of membrane angulate. Posterior femora reaching beyond apex of abdomen, but not beyond apex of elytra. Abdomen basally constricted.

#### 3. *N. volucer*, sp. n.

Elytra greyish cinereo-hyaline; head, pronotum and scutellum sordid testaceous (scutellum with a more or less reddish tinge). Sterna dilute flavous with a reddish tinge. Legs dilute flavous. Abdomen above blackish, beneath dilute cinereous. Basal 2 segments of antennæ brownish-black (more or less); 3rd sordid testaceous; 2nd a little more than 3 times as long as 1st, and ¼ longer than 3rd. Elytra with short, somewhat stiff hairs.

Long. 4 mill., lat. 1 mill.

*Hab.* Isle Réunion, St. Denis.

#### 4. *Systellonotus palpator*, sp. nov.

Blackish-brown, shining. Antennæ stramineous, more or less infuscate. Legs pallid, more or less infuscate, basal ⅔ of posterior femora dark. Elytra fuscous, cuneus and lateral margins darker; a small spot at junction of clavus, corium, and membrane, and 2 large corial spots (at base and apex—the latter extending a little on to the clavus)—white. Membrane pale fuscous, a white central transverse band. Venter black.

♂ Body sparsely and shortly pilose. Head (with eyes) broader than long, short behind the eyes, the latter prominent. Antennæ not incrassate, 2nd segment 4 times as long as 1st, ⅔ longer than 3rd.

Long. 3½ mill., lat. nearly 1 mill.

*Hab.* SIND, Karachi.

### 5. *Sphinctothorax montandoni*, sp. nov.

(Plate V, fig. 3; Plate VI, fig. 3.)

Superficially like *Orectoderus amœnus*, Uhler, but much larger. Head, apex of 2nd and 3rd segments of antennæ, tarsi, etc., black. Scutellum pale reddish-black. Eyes, pronotum, sterna, elytra, legs, etc., reddish-brown; an oblique band near the base of corium and the base of cuneus—stramineoflavous. Antennæ stramineoflavous, 1st segment infuscate. Membrane cinereohyaline, nervures dark brown.

Head nearly vertical in front of the eyes, wider at eyes than the anterior lobe of pronotum. Eyes forming continuous curve with the lateral margins of the head. Head three times as long as 1st segment of antennæ (which does not reach to apex of head); 2nd segment apically incrassate, nearly 5 times as long as 1st and nearly twice as long as 3rd. Rostrum reaching to base of intermediate coxæ. Coxæ somewhat long, anterior pair inserted in the anterior lobe of the sterna. Hamus very obscurely indicated.

Long. 9 mill., lat. 2¼ mill.

*Hab.* ZANZIBAR.

This genus, which is probably an ant-mimic, is closely allied structurally to the American *Orectoderus*, Uhler, which is catalogued by Atkinson among his Plagiognatharia, but which, however, belongs to his Pilophoraria.

### *Hekista*, gen. nov.

Densely, somewhat coarsely, pilose. Head shining, smooth. Pronotum strongly but finely punctured, except on the smooth anterior callosities. Head almost vertical, longer than high, vertex transverse, very short, basally marginate. Pronotal collar narrow, pronotum about ⅔ longer than 1st segment of antennæ, roundly convex, base convex. Elytra rugose-punctate. Posterior femora not reaching to apex of abdomen, elytra reaching well beyond the latter. First segment of posterior tarsi a trifle longer than the 2nd.

This genus has no near allies, being distinguished from the other "Pilophoraria" (of Reuter) by the short vertex, of which the apical margin is very slightly roundly produced (almost truncate) in front

of the eyes (as seen from above) by the proportions of the posterior tarsi, the strongly punctured pronotum, etc.

6. *H. laudator*, sp. nov. (Plate VI, fig. 4.)

Elongate, parallel-sided. Shining black, pilosity pallid. Head, apical half of 1st segment of antennæ, an obscure ring on posterior femora—dark fuscotestaceous; legs (including coxæ, but excluding the black 3rd segment of posterior tarsi), basal half of 1st antennal segment, lateral margins of pronotum very narrowly, lateral margins of elytra, exterolateral margin of clavus, flavotestaceous. Vertex a trifle wider than the 2 eyes together. Apical half of 1st segment of antennæ a little swollen. Pronotum anteriorly with 2 submedian impressions. Eyes touching pronotum, of which the base is rounded. Orifices tuberculo-elevate exterolaterally.

Long. 4·4 mill., lat. 1·4 mill.

*Hab.* Pulo Laut.

7. *Orectoderus obliquus*, Uhler. (Plate VI, figs. 1, 2, 5, 23.)

The apterous form of this species is doubtless an ant-mimic, and is not unlike that of some of the European genera.

♀ Black (greenish-bronzy reflections); antennæ (except apex of 2nd segment), tibiæ, etc., dark reddish-brown. Pronotum truncate apically and basally, subrotundate laterally, base scarcely wider than apex. Meso- and metanotum and 1st 2 (?) segments of abdomen not wider (a little narrower) than pronotum. Abdomen widening roundly from base of 3rd (?) abdominal segment, 3rd to 6th segments forming a subelongate globe. Elytra short, reaching to the middle of 2nd (?) segment.

*Hab.* America, Massachusetts, Lowell.

The male (macropterous form) is also figured.

8. *Berta lankanus* (Kirby).

Java. Previously described from Ceylon.

*Hesperolabops*, gen. nov.

Closely allied to *Labops*, Burmeister, but differing radically in structure of head and pronotum.

Elongate, parallel-sided, vertex and face medianly sulcate (anteriorly rounded), the prominent interolaterally emarginate eyes fixed on long elevated peduncles which rise obliquely from the base.

Vertex short (half the length of the pronotum), about 4 times as wide as the eyes together. Face vertical, long triangular, genæ insignificant. Pronotum constricted at the middle and collared anteriorly, the collar wide and lobate, projecting anteriorly over the base of the head, anteriorly elevated, apical margin sinuate; callose behind the collar near the lateral margins, collar and anterior lobe widely subreflexed laterally; posterior lobe diverging rotundately, $\frac{3}{5}$ wider at base than the apical margin of the anterior lobe. Posterior lobe and elytra minutely punctured. Elytra reaching far beyond apex of abdomen, the membrane apparently with one cell only.

9. *H. gelastops*, sp. nov. (Plate V, fig. 2.)

Vertex, face, scutellum (except black lateral margins), ventral surface, etc., pale sanguineous. Clypeus, collar, anterior lobe of pronotum, lateral margins of pronotum and of elytra, coxæ, etc., pale flavous. Eyes, upper margin of peduncles, pronotal callosities, brownish. Posterior lobe of pronotum (except lateral margins), elytra (except lateral margins)—black.

Long. nearly 6 mill., lat. $2\frac{1}{3}$ mill.

*Hab.* Mexico, Guanajuato.

10. *Sysinus floridulus*, Distant.

Brazil, Sta Catharina. The 1st segment of the antennæ is somewhat incrassate towards the apex.

11. *Neofurius aurora*, sp. nov.

Very close to *N. amethystus*, Distant, but larger and differently coloured. Head, collar, anterior lobe of pronotum (except a thin median scarlet line), 1st segment of antennæ and extreme base of 2nd, legs (except the scarlet-tinged posterior femora), apical $\frac{2}{3}$ of cuneus, and membrane (except extreme base)—pale luteous. Elytra, pronotum and anterolateral part of scutellum—scarlet; remainder of scutellum, clavus (except base), interomedian part of corium, bluish-black. Eyes reddish-black. Underneath luteostramineous. Covered (especially on elytra and scutellum) with short, close, pale yellow hairs (not pubescence); tibiæ shortly pilose. Pronotum *closely* punctured.

Long $4\frac{1}{2}$ mill.

*Hab.* Amazons, Itaituba.

In this species the vertex is glabrous, shining and rounded; in *affinis*, Distant (the only other species of the genus I possess), of which I have a variety from Ecuador,

the vertex is not glabrous, and is somewhat pilose. In *affinis* the 1st segment of the antennæ is thicker in proportion than in *aurora*, and moreover in the latter the 2nd segment is about $\frac{2}{3}$ longer than the 1st, while in *affinis* it is $2\frac{1}{2}$ (or nearly) times as long as the 1st. Mr. Distant had only carded specimens (as is also the case with mine), and full structural details are therefore still wanting. It is possible that *amethystus* and *aurora* will be placed ultimately in a separate genus.

### *Resthenia*, Spinola.

The type of this genus is :

### 12. *R. scutata*, Spinola.

1837. Essai sur les Hémiptères, p. 185, from Brazil, not included in Atkinson's Catalogue, and not mentioned, so far as I know, by any authors since Amyot and Serville.

### 13. *R. simulacrum*, sp. nov.

Very like *R. luteigera* (Stål), from Mexico, in appearance, but structurally different and distinguished at once by the black head.

Head, eyes, antennæ, a large triangular spot on pronotum (occupying the whole of the posterior lobe except the sides), scutellum, apical half of clavus, a broad transverse band on middle of corium, cuneus (except exterobasal angle), legs entirely, dead black. Collar, callosities, lateral margins (widely) of pronotum, base of clavus and corium, apical 3rd also of the latter, prosternum (mesosternum less or more), bright luteous obscurely and faintly mottled with orange-red. Membrane dark fumate. Abdomen beneath obscure pallid smoky. Second antennal segment as thick as the 1st, $2\frac{5}{6}$ longer than the latter, 3rd twice as long as the 1st. Pronotum $\frac{1}{3}$ longer than the 1st segment, acutely reflexed anteriorly at the sides of the callosities, somewhat obtuse (not reflexed) posterolaterally.

Long. 10 mill.

*Hab.* N. Brazil, Itaituba.

The black markings on pronotum, scutellum and elytra bear a ludicrous resemblance to the head and shoulders of a man in a pith helmet.

14. *R. berta*, sp. nov. (Plate V, fig. 10.)

Head above and below, pronotum and scutellum, luteous. Eyes, antennæ, a central line on pronotum, and a dot on each side of the middle at the base of the callosities, and the posterior margin infuscately (these pronotum markings less or more obscure); a median wedge-shaped stripe on scutellum, not reaching the base; tibiæ, tarsi, and apex of femora, brownish-black or blackish. Elytra greyish-black, clavus (except exterolateral margin), an irregular longitudinal marmorate stripe on corium, and cuneus, very pale, greyish-greenish white. Membrane fumate. Femora sordid testaceous. Venter immaculate creamy white. Rostrum reaching intermediate coxæ. Second segment of antennæ slightly incrassate apically, but not so stout as the 1st, and a little more than twice as long; 3rd almost as long as 1st. Pronotum $\frac{1}{3}$ longer than 1st segment of antennæ, lateral margins entirely, but somewhat feebly, acute, not or scarcely reflexed.

Long. $9\frac{1}{4}$ mill.

*Hab.* N. Brazil, Itaituba.

Readily distinguished by its colouring.

15. *Lomatopleura hesperus*, nov. nom. (Plate V, fig. 1.)

*Capsus coccineus*, Walker (nec Meyer, 1843); 1873 Cat. Hem. Heter., Brit. Mus., vi, p. 93.

This species, of which I possess examples from Florida (labelled by a well-known American entomologist *Resthenia insignis*!!), is closely allied to *L. cæsar*, Reuter. Does it really belong to the Capsaria?

16. *Neurocolpus nubilus*. (Plate VI, fig. 24.)

*Capsus nubilus*, Say, 1832, Heter. Hem. (N. Harmony), p. 22.
*Neurocolpus mexicanus*, Distant, 1883, Biologia, Rhynch., I, p. 262, pl. xxiii, fig. 5.
*Neurocolpus affinis*, Distant, l. c., p. 263.

Distant's figure represents one of the pale forms of this protean species. I have a very variable colour series from Costa Rica, the species being distributed from Canada to Panama. The antennæ are very remarkable, the setæ (as noted by Distant) with which the 1st segment is clothed, being dilated apically.

*Kosmiomiris*, gen. nov.

Head small, transverse (as seen from above), short, vertical in front of the eyes. Vertex superficially sulculate longitudinally, not marginate. Eyes together broader than the vertex, interior margins diverging apically, basal margins above sinuately emarginate. Eyes in profile very broad. Rostrum reaching to the base of the apical 3rd of abdomen. Antennæ long. Pronotum strongly punctured, convexly elevated, collar distinct and somewhat broad. Lateral margins of pronotum rounded, not greatly divergent, not reflexed. Scutellum slightly callose. Elytra extending well beyond apex of abdomen, parallel-sided. Legs slender.

This genus is not very closely related to any other known to me.

17. *K. rubroornatus*, sp. nov. (Plate V, fig. 4; Plate VI, fig. 6.)
= *Capsus lucidus*, Walker, l. c., p. 124, ♂ (nec Kirschbaum).

Vertex, apex of abdomen above and below, basal ½ of posterior tibiæ, antennæ, etc., shining black. Pronotum, scutellum, cuneus (less or more), membranal nervures, etc., dull brownish-black (scutellum a little redder). Basal part of 3rd segment of antennæ and apical ½ of posterior tibiæ, whitish. Eyes blackish or reddish. Frons pallid sanguineous. Collar pallid. Elytra yellowish hyaline. Clavus (except basally, where it is black) and 2 oblique outwardly diverging stripes on the corium near the base; posterior femora rostrum (mostly)—deep crimson. Base of cuneus whitish hyaline. Membrane fumate. Venter pale flavous; sterna, etc., black. First segment of antennæ as long as pronotum (excluding collar), broader at apex than at base, 2nd nearly twice as long as 1st. [3rd longer than 1st, 4th shorter than 1st (sec. Walker).] Posterior femora scarcely incrassate.

♀. Long. 5⅔ mill., lat. 2 mill.

*Hab.* Pulo Laut (type); Sarawak. (Brit. Mus.)

*Var.* Sterna pallid; lateral margins of pronotum pallid.

♀. Long. 7½ mill., lat. 2⅓ mill.

*Hab.* Malacca, Perak.

18. *Hyalopeplus lincifer* (Walker).

= *Capsus lincifer*, Walker, l. c., p. 122.

*Hab.* Malacca.

*Malacopeplus*, gen. nov.

Closely allied to *Hyalopeplus*, Stal, differing in the form of the pronotum, membranal areole, etc.

Head vertical, vertex as wide as the 2 eyes together, eyes not quite touching pronotum. First segment of antennæ much longer than head, 2nd a little longer than 1st, 3rd subequal to 2nd. Rostrum reaching to posterior coxæ. Collar and pronotum medio-longitudinally carinate (the carina not reaching the base of the latter); the collar wider than the 2nd segment of the antennæ at base. Pronotum very finely densely punctured, lateral margins not greatly widened posteriorly, raised posteriorly, base truncate. Cuneal fracture not profound, cuneus longer than wide. Interior membranal cell long, acutangular, reaching well beyond apex of cuneus; exterior cell small, not extending so far as apex of cuneus. Posterior femora extending beyond apex of abdomen.

19. *M. discoidalis* (Walker).

= *Capsus discoidalis*, Walker, l. c., p. 122.

*Hab.* Malacca and Singhapur.

*Umslopogas*, gen. nov.

Not or only very finely and minutely punctured, very pilose. Vertex immarginate, impressed transversely at base; obscurely sulcate longitudinally. Head declivous, longer than high, vertex as wide between the eyes as an eye. Rostrum reaching to intermediate coxæ. Eyes scarcely touching pronotum. First and 2nd segments of antennæ stouter than the rest. First segment shorter than pronotum; 2nd segment longer than the width of pronotum at base. Collar wide, pronotal callosities pronounced, but not extending to lateral margins, which are fairly straight. First segment of posterior tarsi twice as long as 2nd; 3rd nearly as long as 1st; 1st much stouter than either 2nd or 3rd.

Differs from *Pachypterna*, Fieber, by the more oblong form, shorter pronotal callosities, longer collar, longer basal segment of the antennæ, 2nd segment not (or scarcely) incrassate apically, and by the longer 3rd segment of the posterior tarsi, etc.

20. *U. nigroquadristriatus*, sp. n.
(Plate V, fig. 11; Plate VI, figs. 7, 25.)

Pale greenish stramineous; a central stripe (not reaching to the base) and 2 spots near the base of head and base more or less; 4

broad longitudinal stripes on pronotum (the 2 median not extending on to the anterior lobe and not quite reaching to the slightly reflexed posterior margin), lateral margins of scutellum, etc. black. Elytra more dilute, striped with brownish-grey, lateral margins and the cuneus immaculate. Membrane fumate, not marbled, nervures flavostramineous. First 2 segments of antennæ blackish, 3rd obscure brownish. Legs obscure brownish, spotted and striped with black. Ventral surface greenish-testaceous, mesosternum striped with black; abdomen sublaterally and tarsi, blackish. Second segment of antennæ $2\frac{1}{2}$ times as long as 1st, $\frac{1}{2}$ longer than 3rd. Interior membranal area sometimes angularly rotundate apically, sometimes acutangular.

Long. $6\frac{1}{2}$–$7\frac{1}{2}$ mill., lat. 2 mill.

*Hab.* NATAL, Howick.

### *Olympiocapsus*, gen. nov.

Smooth, not punctured. Head and pronotum strongly declivous, the former long triangular; vertex as wide between the eyes as the 2 eyes together, obscurely marginate near the eyes, not sulcate. Clypeus prominent, extending beyond apex of vertex. Eyes almost touching pronotum. Rostrum extending to intermediate coxæ. First segment of antennæ distinctly shorter than pronotum, collar comparatively long, about as long as the width of the 1st antennal segment; pronotal callosities obscure. Pronotum and scutellum transversely rugulose; base of the former emarginate, exposing anterior margin of scutellum. Interior area of membrane apically rotundate-angulate. Corium without extra nervures.

Differs from *Dichrooscytus*, Fieb., the only other impunctate genus with laterally marginate vertex, by the long 1st segment of the antennæ. Not unlike *Eurycyrtus*, Reuter, in general appearance, but with longer head, eyes not touching pronotum, and membranal areole more angulate.

### 21. *O. cælestialium*, sp. nov. (Plate VI, figs. 17, 18.)

Black, a posterolateral spot on the vertex between the eyes on each side, a mediolongitudinal stripe on pronotum, the 3 angles of the scutellum, a small ring (with black centre) about the middle of each half of the posterior lobe of pronotum, posterior margin of pronotum, and lateral margins of elytra (very narrowly), a spot near apical margin of exocorium—pale flavotestaceous. Cuneus

sanguineous or sanguineotestaceous (except the black apex). Venter sordid testaceous, more or less marked with blackish-brown.

Long. 7½ mill., lat. 3 mill.

*Hab.* China, Ngan Hoei, Hochan.

This solidly built but sombrely handsome bug has no close palæarctic relations.

*Zulaimena*, gen. nov.

Smooth, not punctured (except obscurely and minutely on the pronotum). Head roundly declivous, long, narrowly convex, vertex immarginate, not sulcate, longer (in profile) than height of head. Eyes touching pronotum. First segment of antennæ shorter than pronotum, much stouter than the length of the collar. Rostrum reaching apex of intermediate coxæ. Membranal areole narrow, apically angulate.

Distinguished from the other impunctate Capsaria by the narrow, pubescent collar, transverse pronotum, convex head, etc.

22. *Z. hathor*, sp. nov. (Plate VI, fig. 8.)

♂ ♀. Subglabrous, pale cinereoflavous with a more or less rufous tint; very sparse pale golden pubescence. ♂ Abdomen ventrally more or less mottled with sanguineous sublaterally. ♂ ♀ Second segment of antennæ 3¼ times as long as 1st, 3rd ½ longer than 1st, ⅛ longer than 4th, each decreasing in thickness.

Long. 5½ mill., lat. 1½ mill.

*Hab.* Guinea, Addah.

*Eblis*, gen. nov.

Pronotum and elytra finely punctured. Head strongly declivous, vertex obsoletely sulculate, clypeus scarcely elevated. Head between eyes about equal to that of an eye, interior margin of the latter not sinuately emarginate, apically divergent. Rostrum reaching beyond posterior coxæ. Head and pronotum immarginate. Antennæ longer than total length of body. Membrane glabrous.

Allied to *Capsus*, Fabr., but differs by the elongate, slender antennæ and by the pronotum, narrower apically.

23. *E. amasis*, sp. nov. (Plate VI, fig. 10.)

Bronzy-black; head, pronotum and scutellum (elytra sparsely) with silvery pubescence. Anterior and intermediate tibiæ, all coxæ, apical half of posterior tibiæ, stinkgland orifices, 3rd and 4th seg-

ments of antennæ—pallid. First segment of antennæ about equal to length of pronotum, the former somewhat incrassate; 2nd segment $2\frac{2}{3}$ longer than 1st, $\frac{1}{5}$ to $\frac{1}{6}$ longer than 3rd, and a little more than twice as long as 4th. Base of pronotum twice as wide as collar. Posterior femora somewhat incrassate, tibiæ about $\frac{1}{3}$ longer than femora.

Long. (including elytra) 7–8 mill., lat. 2–3 mill.

*Hab.* India, Kangra Valley (4500 ft., August 1899, Dudgeon).

*Kangra*, gen. nov.

Somewhat allied to *Hyalopeplus*, Stål, but readily separable by the less robust form, longer and slenderer antennæ, less hyaline elytra, non-carinate pronotum, etc. Elongate, parallel-sided, almost impunctate, smooth above. Head and pronotum subhorizontal. Vertex immarginate with a distinct transverse sulcus; genæ mediocre, clypeus prominent. Rostrum reaching beyond posterior femora. First 3 segments of antennæ longer than body (excluding elytra). Pronotum superficially punctured, transversely sulcate, laterally immarginate, nearly 3 times as wide at base as at collar, widely rounded, lateral margins slightly concave. Elytra extending far beyond apex of abdomen, very finely punctured, cuneus longer than wide at base. Legs elongate.

24. *K. dudgeoni*, sp. nov. (Plate V, fig. 5.)

= *Capsus straminicus*, Walker, l. c., p. 120 (nec Walker, l. c., p. 96).

Head and pronotum pale dirty stramineofuscous. Eyes blackish-brown. A number of oblique striæ on each side of the vertex in front of the eyes, interior margin of clavus, apical margin of corium, membranal nervures—sanguineous. Elytra pale greenish-testaceous. Scutellum blackish-sanguineous, apex of posterior femora dark sanguineous. Venter and legs pale greenish-testaceous. Vertex a trifle wider than an eye, eyes somewhat oblique, not touching pronotum. First segment of antennæ thicker than the others, a trifle longer than pronotum; 2nd $2\frac{2}{3}$ as long as the 1st, slightly longer than 3rd. Posterior femora reaching beyond apex of abdomen, subincrassate, tibiæ $\frac{1}{3}$ longer than femora, 1st tarsal segment shorter than either 2nd or 3rd.

Long. 8 mill., lat. 2 mill.

*Hab.* India, Kangra Valley (4500 ft., August 1899, Dudgeon).

I have pleasure in naming this species after its discoverer, my friend Mr. Gerald C. Dudgeon, whose observations on the oviposition of certain forms are familiar to Rhynchotists. I have also from Mozambique, Rikatla, 2 examples of either this species, or of one almost indistinguishable by appearance or structure.

*Platyngomiris*, gen. nov.

Not closely allied to any genus of its division, and has only 1 membrane cell. It has a strong superficial resemblance to certain Coreinæ. The vesiculate pronotum is also a novelty in this family.

Head strongly declivous, anterior part vertical, posteriorly constricted behind the eyes, wider between the eyes than the eyes together; shortly transversely impressed on the vertex behind the eyes. Eyes prominent, somewhat remote from pronotum, subpedunclular; antennæ inserted in the subpedunculate part of the head close to the interoapical angle of eye, 1st segment incrassate, very short, shorter (in profile) than the length of the eye. Rostrum reaching posterior coxæ. Pronotum and scutellum very strongly, deeply punctured, the former widely collared in front, base of the collar widely angularly produced in the middle. Pronotum callose on each side behind the collar, posterior lobe raised and rounded, base sinuately emarginate, posterolateral angles prominent, rounded. Pronotum widely reflexed posterolaterally. Scutellum large, vesicular (somewhat as in some Tingidæ) base rounded (as seen in profile). Elytra with only 1 distinct, long, angular, membrane cell, which reaches beyond apex of cuneus.

25. *P. coreoides*, sp. nov. (Plate V, fig. 7.)

Bright fulvoflavescent (somewhat bronzy), pronotum more or less infuscate, a parallel stripe joining the eyes; the pronotal callosities, cuneus, apical margin of each connexival segment above and below (connexiva not separated distinctly from abdomen below), antennæ above, rostrum, legs, etc.—black. Pronotal punctures bright amber-coloured. Whole ventral surface more or less obscurely marked with black, membrane dilute flavocinereous, nervures pale flavous. Pronotum with short yellow hairs. Second and 3rd segments of antennæ very thick, 2nd 6 times as long as 1st, ½ longer than 3rd.

♀ Abdomen rounded laterally, connexival segments extending well beyond lateral margins of elytra. Each abdominal segment below narrowly transversely impressed.

Long. 9½ mill., lat. pron. 3¾, lat. max. 4½ mill.

*Hab.* Pulo Laut.

Although this remarkable genus has only 1 distinct membrane cell, it appears to me to belong to the Capsaria.

*Cheilocapsus*, gen. nov.

Somewhat remotely allied to *Hyalopeplus*, Stål, but at once separable by the opaque elytra and differently formed pronotum.

Vertex feebly marginate near the base; clypeus vertical, prominent, extending beyond vertex. Eyes prominent, anterolaterally sinuately emarginate, oblique, together wider than vertex, remote from pronotum. Rostrum extending to intermediate coxæ. Pronotum with a well-marked collar, obsoletely callose behind the latter, lateral margins a little sinuately divergent posteriorly, $2\frac{3}{5}$ wider at base than at apex, subrugose transversely, posterior margin subrotundately truncate. Elytra subrugose-punctate, extending beyond apex of abdomen, the larger membranal area angular apically. Cuneus very elongate.

26. *C. flavomarginatus*, sp. nov. (Plate VI, fig. 9.)

Clothed with short, black, bristly hair. Head, pronotum, extreme base of scutellum, legs and ventral surface, dull flavous. Exocorium, cuneus (except black interobasal angle and extreme apex) bright flavous. Antennæ sanguineous, apex of 2nd segment blackish. Eyes, lateral margins (narrowly) of pronotum, scutellum, elytra, membranal nervures, etc., black. Membrane cinereohyaline. Posterior femora with 4 small black spots. Dorsum of abdomen sanguineous. Head with a slight longitudinal sulcus. First segment of antennæ subincrassate, subequal to pronotum in length, a trifle longer than cuneus, 2nd a little more than twice as long as the 1st. First segment anterior tarsi longer than 2nd and 3rd together.

Long. 11 mill., lat. pronot. $3\frac{1}{4}$ mill.

*Hab.* Burma, Chan Yoma.

*Eurybrochis*, gen. nov.

Somewhat similar in appearance to *Camptobrochys*, Fieber, but vertex entirely marginate. Allied to *Lygidea*, Reuter, but with longer head, eyes not touching pronotum, eyes (as seen in profile) longer, basally emarginate.

Pronotum and elytra very strongly punctured, not (or very indistinctly) pubescent. Vertex, callosities, collar and scutellum smooth, shining. Head declivous, a little more than twice as long as high (profile). Vertex about as wide as an eye. Eyes not touching pronotum. Antennæ inserted distinctly within the lateral margins of the eyes, 1st segment extending well beyond apex of clypeus. Rostrum reaching posterior coxæ, 1st segment extending just beyond base of head. Collar wider than apex of 2nd antennal segment. Pronotal callosities confluent, part anterior to them smooth, shining, not punctured, pronotal lateral angles prominent, base sinuately rotundate. Scutellum subconvex, impressed transversely near the anterior margin. Elytra a little wider at the base than the base of pronotum, cuneus a little longer than broad. Posterior femora scarcely thicker than the others. First segment of tarsi distinctly shorter than 2nd and 3rd together, 1st longer than 2nd.

27. *E. zanna*, sp. nov. (Plate V, fig. 8; Plate VI, fig. 11.)

This species is very variable within certain limits.

General colour testaceous, less or more suffused with greenish, brownish or pink (varieties). Scutellum usually with 2 longitudinal stripes; apices of corium, exocorium and cuneus, blackish-brown. These marks are nearly always present, also sometimes spots and blotches of the same colour on clavus and corium. Membrane less or more marbled. Clavus and corium in 1 example almost entirely black. Legs sordid pallid fuscotestaceous, annulated with fuscous; antennæ rufotestaceous (or greenish), apex of 2nd segment black. Venter sordid, less or more marked with blackish.

Long. $5\frac{3}{4}$—$6\frac{1}{2}$ mill., lat. 2 mill.

*Hab.* AUSTRALIA, Victoria, Alexandra.

*Korasiocapsus*, gen. nov.

This genus cannot be confused with any Ethiopian one, and appears also to have no near Palæarctic ally. It is one of the smallest (judging from the two specimens composing the at-present unique species) in size of the Capsaria, and combines several of the characters of the two principal groups into which Reuter divides the Palæarctic genera.

Generally impunctate (or only very remotely punctured), sparsely shortly pilose, pronotum rugose-punctured. Vertex immarginate

(superficially sulcate longitudinally, and also superficially impressed transversely between the eyes) about as wide as an eye. Head horizontal as far as apex of eyes, then strongly declivous. First segment of antennæ extending far beyond apex of head, inserted (looking from above) within the interoapical angle of eyes, equal in length to pronotum. Eyes almost touching pronotum, internal margins convexly rounded. Pronotum not reflexed laterally, lightly sinuate; base gently convexly rounded, about ½ wider than head (with eyes); callosities not confluent; collar distinct. Costal margin of elytra widening towards apex; cuneus longer than wide. Legs slender, femora short.

28. *K. pylaon*, sp. nov.

Bright sanguineous (including membranal nervures). Eyes, 1st segment of antennæ, and tarsi, black. Head, lateral margins of elytra, cuneus (except a little sanguineous internally) pale flavous. Membrane fumate. Legs pale flavous (irregularly and sparsely marked with sanguineous). Ventral surface pale flavous, widely bordered dilutely with sanguineous.

Long. 4⅓ mill. (including elytra), lat. 1½ mill.

*Hab.* MOZAMBIQUE, Rikatla.

*Proboscidocoris*, Reuter.

Reuter's typical species (of which I possess a cotype) was described from specimens lacking legs, etc. The posterior femora are somewhat incrassate, and do not reach as far as the apex of the abdomen, and the 1st segment of the tarsi is very short.

29. *P. seti*, sp. nov. (Plate VI, fig. 12.)

Closely allied to *P. fuliginosus*, Reuter, from Guinea, but more robust and quite differently coloured.

Dead-black, above and beneath, with pale golden pubescence. Antennæ fulvous, excepting the black 1st segment and apex of 2nd; coxæ, anterior and intermediate femora, apical ½ of posterior femora and apical 3rd of all tibiæ, black; the rest of the legs fulvous or fulvotestaceous. First 3 segments of rostrum fulvotestaceous, 4th black. Membrane fumate, nervures fuscotestaceous. Vertex (♀) a trifle wider than in *fuliginosus*, and the eyes not quite so elongate.

Long. 5·8 mill., lat. 2·7 mill.

*Hab.* MOZAMBIQUE, Rikatla.

30. *Eurystylus costalis*, Stål. (Plate VI, figs. 13, 20.)

Stål has placed this near *Atractotomus*, Fieber. It appears to me, however, to belong to the Capsaria, on account of the distinct (comparatively) long collar, and the remoteness of the coxæ from the lateral margins of elytra, the absence of an alar hamus, etc.

To Stål's description add

Pubescence yellowish and silvery. Ventral surface pale fulvous; mesosternum with a central stripe and a large lateral spot—black; abdomen with a sublateral spot on each segment. Eyes contiguous with pronotum; 1st segment of antennæ equal to pronotum in length, 3½ times as long as wide; 6 or 7 times as wide as the 2nd at apex. Second segment slightly incrassate apically, nearly twice as long as 1st. Stinkgland orifices wide, emarginate. Collar much wider than 2nd antennal segment. Pronotum immarginate laterally. Cuneus declivous; interior area of membrane rounded apically. ♀ ovipositor, etc., blackish.

The specimens in my collection are from Tolo (Philippines) and from Ardjeano (Java).

31. *Dcræocoris sacratus*, sp. nov.

Eyes, 3 apical segments of antennæ, pronotal callosities, pronotum (except lateral margins widely), elytra, etc., shining black. Head, 1st segment of antennæ, a wide entire longitudinal stripe on corium, femora (apex pallid), sordid fuscotestaceous. Lateral margins of pronotum (widely) except extreme apex and base, base very narrowly, collar and extreme base of 3rd segment of antennæ, whitish testaceous. Membrane fumate. Venter brownish-black. Second segment of antennæ 3⅔ as long as 1st, nearly twice as long as 3rd, and ½ longer than 4th. Collar glabrous, pronotum densely impresso-punctured; tibiæ not spinose, obscurely annulated with pallid. Rostrum reaching to posterior coxæ.

Long. 4¾ mill., lat. 1¾ mill.

*Hab.* Pulo Laut.

32. *Lygus osiris*, sp. nov.

Greenish-testaceous (including membrane-nervures); 2 longitudinal submedian vittæ and the lateral margins of scutellum, 2 spots on clavus near claval suture, 2 subobliique stripes on corium, pale sordid purple fuscous. Ventral surface pale greenish-testaceous.

Two apical segments of antennæ fuscous. Pubescence flavous. Vertex somewhat feebly, but entirely, marginate. Rostrum reaching well beyond posterior coxæ. Second segment of antennæ longer than width of head (including eyes), 3rd segment about equal to the latter. Tibiæ entirely (except obscurely apically) pallid, somewhat feebly spinulose.

♂. Vertex distinctly wider than an eye.

♀. Vertex distinctly narrower than an eye.

Long. 4¾ mill., lat. 2 mill.

*Hab.* Isle Réunion, St. Denis; Mozambique, Rikatla.

Closely allied to *L. approximatus* (Stål) from Sitka.

### *Tinginotum*, gen. nov.

Long oval; vertex somewhat obtusely marginate, less so medianly. Eyes touching pronotum. Head almost vertical, longer than high, vertex a little wider than an eye, longitudinally sulcate between the eyes, clypeus prominent. Collar wider than the 2nd segment of antennæ at apex; pronotum strongly but somewhat minutely impresso-punctured, very convex, and greatly elevated posteriorly, base rounded. Pronotum longer than 1st segment of antennæ, but much shorter than 2nd. Elytra not, or scarcely, punctured. Costal area (comparatively) very broad, widening basally; cuneus a little longer than broad; membrane obscurely marbled, nervures rotundate angulate. Posterior femora not reaching so far as apex of abdomen. First segment of posterior tarsi much shorter than 2nd.

Differs from the other Capsaria (except *Stethoconus*, Fieber, which is quite different) by the impunctate elytra and punctured pronotum.

### 33. *T. javanum*, sp. nov.

Sordid rufoflavous; antennæ blackish-brown or rufobrunneous, annulated with pallid. Base of clavus blackish-brown. Elytra and venter pale rufoflavous, the former mottled with darker. Legs sordid pale rufoflavous, annulate with blackish-brown. Membranal nervures stramineous. Second segment of antennæ twice as long as 3rd, which is a trifle longer than the 1st, the 3 apical slender, 2nd slightly incrassate apically.

Long. 5⅛ mill., lat. 2 mill.

*Hab.* Java.

34. *Disphinctus sumatrator*, sp. nov.

♀. Entirely castaneous (with pale golden pubescence) except—eyes pale; 2nd to 4th segments of antennæ, an annulus on the middle of anterior and intermediate femora, the posterior tibiæ, an irregular blotch at apex of corium, cuneus (except extreme base and very narrowly the interior margin), black. Membrane (excluding nervures) greenish-cinereous-hyaline. Pronotum smooth, base emarginate. Legs with somewhat long, bristly golden hairs. Second segment of antennæ 3⅗ as long as the 1st, which is twice as long as the head.

Long. 11½ mill.

*Hab.* SUMATRA.

35. *D. anadyomene*, sp. nov.

= *Capsus fasciatus*, Walker, l. c., p. 122 (nec Meyer, 1843).

This lovely species from Singhapur is of a delicate dark coral-red colour.

36. *Monalonion atratum*, Distant.

*Hab.* ECUADOR, Quito.

37. *M. xanthophilus* (Walker).

= *Capsus xanthophilus*, Walker, l. c., p. 110 (Brazil).
= *Resthenia xanthophilus*, Atkinson, p. 62 ! !

38. *M. pilosipes*, sp. n.

Head, antennæ (entirely), anterior lobe of pronotum, legs (except an obscure pallid ring on the middle of the intermediate tibiæ, and an obscure reddish ring on the middle of the posterior femora), metasternum, genital segments above and beneath, elytra, etc., shining black. Posterior lobe of pronotum, scutellum, abdomen above and beneath, pro- and mesosterna, dark sanguineous. Head nearly twice as long as 1st segment of antennæ, 2nd segment between 9 and 10 times as long as 1st. Base of pronotum truncate. Posterior tibiæ curved, and very pilose, as also posterior femora.

Long. 10¼ mill.

*Hab.* ECUADOR, Quito.

39. *M. megiston*, sp. nov.

Closely allied to *M. dissimulatum*, Distant, but larger,

base of pronotum only slightly emarginate, antennæ entirely black and with different proportions.

Scutellum entirely pale. Posterior lobe of pronotum reddish-ochraceous. Anterior and intermediate legs pallid, except base of femora; posterior legs entirely black, except a broad pale yellowish ring on middle of femora. Abdomen black. First segment of antennæ very short, $\frac{1}{4}$ shorter than head; 2nd nearly 8 times as long as first, $\frac{1}{7}$ longer than 3rd.

Long. ♀ 11½–15 mill.

*Hab.* AMAZONS (type); ECUADOR.

40. *Helopeltis waterhousei*, sp. nov.

Differs from *H. bergrothii*, Reuter, by the colouring and by the different proportions of the antennæ.

♀. Frons and clypeus pale; elytra, legs (except pallid coxæ and basal half of femora), antennæ (except orange-red base of 1st segment), scutellum, etc., shining black. Anterior lobe of pronotum orange-red. Abdomen above and below bright sanguineous. Second segment of antennæ $\frac{1}{3}$ longer than 1st, subequal to 3rd ($\frac{1}{13}$ longer).* The basal 4th of the scutellar horn is directed slightly backwards, the apical $\frac{3}{4}$ directed forwards at an obtuse angle (nearly right angles).

*Hab.* GABOON.

41. *H. insularis*, sp. nov.

♀. Shining black; anterior lobe of pronotum, base of scutellum, legs (except tarsi and apex of femora and 1 or 2 more or less obscure spots on femora), connexivum above—pale reddish-testaceous. Elytra dark reddish-black. Antennæ, rostrum, venter, etc., entirely black.

♀. Var. 1. Entirely black. Cuneus faintly red. Legs dark testaceous.

♀. Var. 2. Second to 4th segments of antennæ obscurely pallid.

♂. Black, except the obscurely reddish cuneus. Basal half of 1st segment of antennæ testaceous. Posterior legs testaceous, femora spotted with black.

♂ ♀. Second segment of antennæ $\frac{3}{5}$ longer than the 1st, $\frac{2}{5}$ longer than the 3rd. Scutellar horn somewhat elongate, almost erect and straight.

Long. ♂ 6 mill., ♀ 7½–8 mill.

*Hab.* PULO LAUT.

* In *bergrothii* the 2nd is more than $\frac{1}{6}$ longer than the 3rd.

42. *Megalocerœa cœlestialium*, sp. n.

Closely allied to *M. ruficornis* (Fourcroy) but a little smaller, head more depressed, posterior femora slenderer, etc.

Dilute greenish ; a median line on head, 4 lines on pronotum, 2 on scutellum, etc., brownish-cinereous. Antennæ, apex of posterior tibiæ and the 1st 2 tarsal segments rosaceous. Eyes blackish. Third segment of posterior tarsi and claws black.

Second segment of antennæ 3 times as long as 1st, and $\frac{1}{7}$ longer than 3rd.

Long. nearly 6 mill., lat. $1\frac{1}{6}$ mill.

*Hab.* China, Nan King.

43. *Eioneus bilineatus*, Distant.

*Hab.* Costa Rica.

This genus is closely allied to *Megalocerœa*.

44. *Collaria oleosus* (Distant).

*Hab.* Costa Rica, San José.

The colour of the pronotum is somewhat variable ; at one extreme only the posterolateral spots are well-marked, while at the other, beside the 4 typical spots, there is a 5th—in the middle of the posterior margin.

*Eurymiris*, gen. nov.

Allied to *Tetratoeris*, Fieber, but differs by the apically rounded head.

Vertex between the eyes, $2\frac{1}{3}$ times as wide as an eye, transversely impressed, anteriorly rounded, basal half superficially sulculate longitudinally, not narrowed behind the eyes, which are remote from the pronotum, prominent and almost pedunculate, extending laterally well beyond the base of the head. Pronotum anteriorly constricted, anterolaterally callose behind the constriction, lateral margins sinuate, diverging posteriorly ; posterior margin truncate, obtusely tuberculate laterally. Scutellum obtusely rounded. First segment of tarsi twice as long as 2nd, tomentose beneath, 2nd inserted subapically, 3rd apically.

45. *E. curynome*, sp. nov. (Plate VI, fig. 21.)

Glabrous ; head, pronotum and scutellum very smooth, the 2

last superficially transversely rugose. Elytra rugose-punctate, interior area of membrane much longer than exterior, the latter coriaceous.

Pale (slightly greenish) testaceous. Eyes black. Anterior femora apically, and anterior tarsi, blackish. Elytra pale olivaceous ; clavus centrally and subexterolaterally, corium subcostally—narrowly blackish. Membranal nervures and abdomen pale greenish-testaceous.

Long. $9\frac{3}{4}$ mill., lat. max. 2 mill.

*Hab.* AUSTRALIA, Victoria, Alexandra.

*Austromiris*, gen. nov.

Allied to *Megaloccræa*, Fieber, but differs by the slightly transverse, apically rounded head, etc.

Vertex scarcely impressed or sulcate, basally somewhat feebly marginate. Eyes not touching pronotum. Pronotum constricted a little above the middle, anterior lobe laterally rounded, callose submedianly on either side, with a small impression on either side of the middle. Posterior lobe transversely rugose, lateral margins sinuately divergent, posterolateral angles prominent, subacute, posterior margin sinuately emarginate, exposing apex of scutellum. Membranal areas entirely membranous.

46. *A. viridissimus*, sp. nov. (Plates V, fig. 12 ; VI, fig. 22.)

Smooth, glabrous (except posterior lobe of pronotum). Head, scutellum, legs, etc., greenish-testaceous. Pronotum and elytra green, some spots on head and anterior lobe of pronotum, the greater part of posterior lobe, mediolongitudinal stripe on scutellum and exterolateral angles of the latter—blackish or greenish-black. Claval and corio-claval sutures and a stripe along middle of corium, antennæ, tarsi and tibial spines, blackish or brownish-black. Venter more or less dilute green. Membrane fumate, nervures pale flavous. First segment of antennæ much longer than vertex, a trifle longer than pronotum, more than twice as wide as 2nd segment. Second segment 3 times as long as 1st, which is subequal to the 3rd. Rostrum reaching nearly to apex of intermediate coxæ.

Long. 8 mill., lat. nearly 2 mill.

*Hab.* AUSTRALIA, Victoria, Alexandra.

This species varies a little in colouring, principally in the depth of tint of the green; thus the clavus and interior half of corium are sometimes dark green, the exterior half of corium greenish-yellow, these areas being separated

by a narrow pale brownish-black stripe. The head is sometimes immaculate, and the posterior lobe of pronotum entirely bright green. The exterior half of corium dark green, and the dark stripes broader.

*Saturniomiris*, gen. nov.

Distinguished by the very wide head (with eyes), which is much wider than the anterior lobe of the pronotum.

Vertex nearly as wide as the eyes together, longitudinally sulcate. Head long, triangular. Eyes very large, semipedicillate. Pronotum constricted before the middle and transversely sulcate, posterior lobe raised, and there is also a narrow, but distinct and somewhat swollen collar. Pronotum finely rugose-punctured, anterior lobe callose mediolaterally, lateral margins rounded, base truncate. Elytra minutely tuberculate. Posterior femora short.

47. *S. tristis* (Walker).

*Capsus tristis*, Walker, l. c., p. 125.

Head and pronotum sordid fuscofulvous (less or more mottled), antennæ and elytra blackish-grey, or blackish. Legs black; apical half of tibiæ, and the tarsi, pallid. First segment of antennæ incrassate, 1st short, 2nd about 2½ (nearly 3) times as long as 1st, 3rd a trifle longer than 4th, both shorter than 1st.

*Hab.* New Guinea.

*Rhinomiris*, gen. nov.

Superficially very like the Nabine genus *Reduviolus* (Kirby).

Head subhorizontal, produced triangularly in front of the eyes, the pre-antennal part somewhat longer than the post-antennal; vertex mediolongitudinally sulcate towards the base. Eyes large, prominent, nearly touching the pronotum. Antennæ longer than thorax and abdomen together, nearly as long as entire body; 1st segment about as long as head. Rostrum very long. Pronotal constriction nearer to the base than the apical margin, the anterior lobe rounded laterally, humped in the middle (the hump longitudinally sulcate); lateral and posterior margins of posterior lobe sinuate, the former divergent posteriorly. Posterior lobe of scutellum humped.

48. *R. vicarius*, Walker.

*Capsus vicarius*, Walker, l. c., p. 121 = ♂.
*Capsus canescens*, Walker, l. c., p. 121 = ♀.

(Plate V, fig. 6; Plate VI, fig. 14.)

Blackish-brown variegated with fuscotestaceous. Vertex apically black, fuscotestaceous (with a brownish central spot) basally; base behind the eyes black. Eyes dark brown. The basal 2 segments of antennæ rufofuscous, the 2nd apically black, extreme apex with a pale annulus, 3rd and 4th blackish, except the pallid extreme base of 3rd. Pronotum apically black, posteriorly brownish-black, a central flavous stripe, and various less or more obscure flavous markings. Scutellum blackish, a median line (anteriorly expanded) and an anterolateral curved line, fuscotestaceous. Elytra blackish-brown with the following fuscotestaceous or sordid flavous *—nervures, margins narrowly (costa somewhat widely), a large number of small spots (except on the corium interoapically) on clavus and corium. Corium exteroapically fumate; membrane somewhat fumate. Legs rufofuscous (less or more obscure) with pale annuli and spots. Venter (in part at least) black. Third segment of antennæ ⅓ longer than 2nd, which is 2½ as long as the 1st, which is slightly longer than the 4th (35, 90, 130, 33). Elytra with short, scant hairs; strongly rugulose transversely; apex of corium acute, reaching as far posteriorly as apex of interior area of membrane, exterior area very small, hyaline. Femora longitudinally subsulcate above, anterior pair the thickest.

♂ Rostrum reaching beyond apex of abdomen. ♀ Rostrum reaching to apex.

Long. 10 mill.

*Hab.* Pulo Laut.

*Zanessa*, gen. nov.

Somewhat allied to *Miris*, Fabr., and has a little the appearance of an elongate *Calocoris*, Fieber.

Covered with short hairs (not pubescence). Vertex, pronotum and scutellum mediolongitudinally carinate; the 1st transversely impressed, and lightly marginate at the base. Eyes globular, prominent, together much wider than the vertex. Rostrum reaching to apex of intermediate coxæ. Pronotum constricted a little in front of the

* The unique types, which are in bad condition, are faded and the pallid markings are whitish mostly.

middle, lateral margins sinuately diverging posteriorly ; base sinuately emarginate, exposing apex of the impunctate, slightly rugose scutellum. Elytra and wings reaching well beyond apex of abdomen. Legs slender, pilosospinose.

49. *Z. rubrovariegata*, sp. nov. (Plates V, fig. 13; VI, fig. 15.)

♀. Head, pronotum and scutellum pale testaceous ; 1st and 2nd segments of antennæ, a submedian line on each side of the carina (of the head, pronotum and scutellum, expanded on the last-named) pale crimson. Apex of 2nd antennal segment above, 1st and 2nd segments beneath, lateral margins of pronotum, 2 submedian apical spots on scutellum, blackish. Elytra pale crimson (widely) and dark purplish-brown (more narrowly) in alternate bands, separated by very narrow pale testaceous lines. Cuneus crimson, extreme apex pale testaceous. Membrane fumate (irridescent crimson and green), nervures crimson. Legs pale crimson-testaceous, coxæ pale testaceous, tarsal segments partly blackish; a black annulus at apex of posterior femora. Abdomen above black, connexivum crimson. Venter pale (greenish) testaceous, spiracles blackish-brown. First segment of antennæ incrassate, twice as thick as 2nd and more than 3½ times as long as head ; 2nd segment 2⅓ times as long as 1st. First segment of rostrum not reaching to the point of the xyphus ; 2nd segment slender, reaching to anterior coxæ ; 3rd reaching to base of intermediate coxæ.

Long. 9¼–9½ mill.

*Hab.* AUSTRALIA, Victoria, Alexandra.

I have also in my collection a single male which is probably referable to this species. It comes from the same locality, is similarly coloured, though a little darker, and the venter is dead black.

Long. 7½ mill.

This is certainly the handsomest Mirarian so far described.

*Bothriomiris*, gen. nov.

Has no near allies and will probably form a new division.

Oblong, broad, pilulose. Entire surface (head, nota, sterna, elytra, etc.), densely, strongly punctured. Vertex, strongly declivous, much longer than high (profile), as wide as the 2 eyes together, not sulcate, basally marginate. Antennæ long, 2nd segment distinctly longer than pronotum. Interior margin of eyes convex, not emarginate. Pronotum without a collar and not constricted latero-medianly,

anteriorly callose, the callosity somewhat deeply sulcate longitudinally, and not densely punctured. Posterior part of pronotum medianly carinate, base truncate, very slightly emarginate, posterolateral angles prominent, obtuse, pronotum widely reflexed at posterolateral angles. Cuneus small, longer than broad. Interior area of membrane very acutangular apically. Posterior coxæ very remote from lateral margins of abdomen ; femora short, incrassate ; tibiæ twice as long as tarsi, 1st tarsal segment much longer than 2nd. Membrane marbled.

50. *B. marmoratus*, sp. nov. (Plates V, fig. 9 ; VI, fig. 16.)

= *Capsus simulans*, Walker, l. c., p. 125 (nec Stål).

Head, anterior part of pronotum, central line or posterior part and scutellum, the more or less obscure marmoration of elytra and membrane—pale flavous more or less suffused with pale sanguineous. Antennæ blackish-brown (paler beneath). Posterior lobe of pronotum and scutellum dark crimson (or reddish-black), reddish-black laterally. Membrane nervures pale flavous. Ventral pale sordid yellow, sterna black laterally, abdomen black laterally irregularly. Elytra with pale golden pubescence. Second segment of antennæ nearly twice as long as 1st, a little incrassate apically.

Long. 7 mill., lat. 2½ mill.

*Hab.* Malacca, Perak (type); Singhapur (British Mus.).

The vertex in one example has a suffused blackish longitudinal stripe ; this is pale sanguineous in the other.

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## Explanation of Plates V and VI.

### Plate V.

Fig.

1. *Lomatopleura hesperus*, Kirk. Head and pronotum.
2. *Hesperolabops gelastops*, Kirk. „ „
3. *Sphinctothorax montandoni*, Kirk.
4. *Kosmiomiris rubroornatus*, Kirk.
5. *Kangra dudgeoni*, Kirk.*
6. *Rhinomiris vicarius* (Walker).
7. *Platyngomiris coreoides*, Kirk.

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* This has been drawn in error with the pronotum tilted forward, showing the root of the elytra, etc.

8. *Eurybrochis zanna*, Kirk.
9. *Bothriomiris marmoratus*, Kirk.
10. *Resthenia berta*, Kirk.
11. *Umslopogas nigroquadristriatus*, Kirk.
12. *Austromiris viridissimus*, Kirk.
13. *Zanessa rubrovariegata*, Kirk.

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## Plate VI.

Fig.

1. *Orectoderus obliquus*, Uhler. . . . . Macropterous ♂.
2. „ „ „ . . . . Apterous ♀.
3. *Sphinctothorax montandoni*, Kirk. . . Head in profile.
4. *Hekista laudator*, Kirk. . . . . „ „
5. *Orectoderus obliquus*, Uhler. . . . . „ „
6. *Kosmiomiris rubroornatus*, Kirk. . . . „ „
7. *Umslopogas nigroquadristriatus*, Kirk. . „ „
8. *Zulaimena hathor*, Kirk. . . . . „ „
9. *Cheilocapsus flavomarginatus*, Kirk. . „ „
10. *Eblis amasis*, Kirk. . . . . „ „
11. *Eurybrochis zanna*, Kirk. . . . . „ „
12. *Proboscidocoris seti*, Kirk. . . . . „ „
13. *Eurystylus costalis*, Stål . . . . . „ „
14. *Rhinomiris vicarius* (Walker) . . . . „ „
15. *Zanessa rubrovariegata*, Kirk. . . . . „ „
16. *Bothriomiris marmoratus*, Kirk. . . . „ „
17. *Olympiocapsus cœlestialium*, Kirk. . . „ „
18. „ „ „ Head and pronotum, dorsal view.
19. *Eblis amasis*, Kirk. . . . . Head and pronotum, dorsal view.
20. *Eurystylus costalis*, Stål. . . . Head and pronotum, dorsal view.
21. *Eurymiris eurynome*, Kirk. . . Head and pronotum, dorsal view.
22. *Austromiris viridissimus*, Kirk. . Head and pronotum, dorsal view.
23. *Orectoderus obliquus*, Uhler. . . Head and pronotum, dorsal view.
24. *Neurocolpus nubilus* (Say). . . Antenna enlarged.
25. *Umslopogas nigroquadristriatus*, Kirk. Posterior tarsus.

## XV. *Lepidoptera from the Chatham Islands.*

By Edward Meyrick, B.A., F.Z.S.

[Read May 7th, 1902.]

The following species of *Lepidoptera* were collected in the Chatham Islands by Mr. J. Fourgère, and transmitted to Professor Hutton, of Christchurch, New Zealand, who placed them in my hands for determination. Little or nothing seems to have been known previously of the *Lepidoptera* of this outlying group of the New Zealand system, and it is exceedingly desirable that no time should be lost in securing representatives of those to be found there. They are probably not numerous, but search should be especially made in those parts of the islands which are furthest removed from the influence of settlement, and also particularly on the highest points, however bleak and exposed these may appear to be.

The present consignment appears to contain 19 species, of which however one is not in a condition to be accurately determined. Of the remaining 18 species, 7 are new to science, 7 are common New Zealand species which are not at all likely to have been introduced by man (two of these occur also in Australia and Tasmania), and 4 are semi-domestic species of more or less wide distribution which have doubtless been artificially imported. The 7 new species are all of characteristic New Zealand genera, and obviously related to New Zealand species of these genera, so that, so far as herein appears, the islands are simply a detached portion of New Zealand.

### Caradrinidæ.

1. *Leucania propria*, Walk.

One specimen, in poor condition, but apparently normal.

2. *Melanchra bromias*, n. sp.

♂ ♀. 34–36 m.m. Head and thorax grey, sometimes whitish-mixed, variably tinged with brownish or reddish, and indistinctly

marked irregularly with blackish streaks. Antennæ in ♂ shortly bipectinated to ½. Abdomen light grey, sometimes ochreous-tinged. Forewings moderately dilated, costa almost straight, apex obtuse, termen crenulate, obliquely rounded; grey, partially whitish-sprinkled, variably and irregularly tinged with purple-brownish, median band and terminal area darker; a short black median longitudinal streak from base; a short similar parallel streak from dorsum near base, sometimes obsolete; first and second lines slender, blackish, waved, nearly obsolete on upper half, fairly distinct and rather nearly approximated on lower half; spots outlined with black, more or less rosy-brownish, especially reniform, orbicular and reniform sometimes whitish-edged, orbicular semi-oval, incomplete above, claviform subtriangular; subterminal line white, sometimes interrupted or partially obsolete, with one prominent dentation below middle (on vein 3), near dorsum more conspicuous and preceded by a triangular dark fuscous spot, elsewhere edged with smaller dark fuscous spots: cilia fuscous, mixed with dark fuscous, and indistinctly barred with whitish. Hindwings light fuscous, darker terminally; cilia whitish, with cloudy dark fuscous line.

Four specimens. Nearest to *M. mutans*, with which it agrees in the rather peculiar character of the single prominent dentation of subterminal line, but darker and duller-coloured, without the black supratornal streak of that species, and differing also by the blackish posterior margin of reniform.

3. *Melanchra composita*, Guen.

Five specimens.

HYDRIOMENIDÆ.

4. *Xanthorhoe roseuria*, Dbld.

One specimen (♂): somewhat peculiar, median band of forewings strongly marked with dark fuscous, its posterior edge more approximately parallel to termen than in any of my New Zealand specimens; in the absence of further material I am disposed to regard it as a local form only.

5. *Xanthorhoe homalocyma*, n. sp.

♂ 24–28 m.m., ♀ 22–26 m.m. Head and thorax pale ochreous, more or less sprinkled or tinged with fuscous. Antennal pectinations of ♂ long (*a* 6, *b* 8). Forewings triangular, apex obtuse, termen

oblique, gently rounded, slightly waved; pale ochreous, sometimes fuscous-tinged, sometimes sprinkled with whitish or dark fuscous; numerous waved brownish-ochreous or fuscous striæ, usually faint in ♂ but more distinct in ♀; edge of basal area angulated near costa, in ♂ sometimes blackish-marked in middle and on dorsum; third and fourth fasciæ (limiting median band) usually darker-suffused, in ♂ sometimes blackish-marked on external edge towards middle and on dorsum, anterior edge curved, posterior slightly prominent in middle and beneath costa; on each side of median band are somewhat paler fasciæ, in which veins are often marked with white, and more or less conspicuously dotted with black; a transverse black discal dot; termen sometimes darker-suffused, especially in ♀, limited above by an oblique dark apical streak: cilia pale ochreous, with two cloudy fuscous lines. Hindwings light grey, sometimes ochreous-tinged; posterior edge of median band sometimes indicated by a faint darker angulated shade; sometimes one or two darker subterminal striæ; cilia as in forewings.

Twenty-seven specimens. Somewhat intermediate between *X. roscaria* and *X. subductata;* markings much as in *subductata,* but forewings without the characteristic yellow-greenish mixture, and posterior edge of median band much less prominent in middle. It also approaches the larger Tasmanian *X. centroneura,* which however is reddish-tinged, and has distinct band of median striæ on hindwings, besides other differences.

### 6. *X. lucidata,* Walk.

Three specimens, somewhat large and pale, but not otherwise different.

## Selidosemidæ.

### 7. *Selidosema ombrodes,* n. sp.

♂ ♀. 32–36 m.m. Head and thorax varying from fuscous to brownish-ochreous. Antennal pectinations in ♂ very long (16), extending to near apex. Abdomen pale ochreous-yellowish, sprinkled with fuscous, in ♂ rather elongate. Legs rather dark fuscous, ringed with whitish-ochreous, posterior tibiæ in ♂ little dilated. Forewings rather elongate-triangular, costa moderately arched, apex obtuse, termen somewhat oblique, rounded; light ochreous, more or less largely suffused with brown, and strigulated with dark fuscous; first and second lines dark fuscous, usually indistinct, first strongly curved, second somewhat irregular, hardly curved on upper $\frac{3}{4}$,

thence obliquely bent inwards; an indistinct transverse blackish discal mark; usually a pale costal spot beyond second line; in one ♀ conspicuous pale fasciæ on each side of median band: subterminal line indistinct, sometimes partially whitish, waved-dentate: cilia rather dark fuscous. Hindwings with termen rounded, gently waved; rather light grey, indistinctly strigulated with darker; cilia pale grey.

Eight specimens. Not to be confused with any other; perhaps nearest allied to *S. productata*, but larger and more sombre, and distinguished from it and all similar New Zealand species by the grey hindwings; the very long antennal pectinations of ♂ are also noticeable.

### Crambidæ.

8. *Crambus ramosellus*, Dbld.

One specimen; much damaged, but does not appear to differ from typical examples.

9. *Crambus horistes*, n. sp.

♂ ♀. 21–26 m.m. Head and thorax pale greyish-ochreous, with some white scales. Labial palpi 4, greyish-ochreous, white towards base beneath. Forewings with apex tolerably rectangular, termen nearly straight, rather oblique, rounded beneath; pale brownish-ochreous; a rather broad straight snow-white longitudinal streak above middle from base to termen, extremity extended upwards to apex, sometimes yellowish-tinged towards base; costal area above this wholly rather dark brown: cilia pale ochreous, suffusedly barred with white. Hindwings whitish-fuscous; cilia white, with a faint subbasal whitish-fuscous line.

Four specimens. Allied to *C. flexuosellus* (no other species has the sharply contrasted dark costal and light dorsal areas), but easily distinguished by the absence of the characteristic dark spots on lower edge of white streak, and by the hindwings not being yellowish.

### Pyraustidæ.

10. *Mecyna marmarina*, Meyr.

Four specimens; normal in all respects. I now regard *Mnesictena*, formed as a genus to include this species and its allies, as properly a group of *Mecyna*.

### 11. *Mecyna pantheropa*, n. sp.

♂ ♀. 25–26 m.m. Head and thorax light yellow-ochreous, sometimes mixed with reddish-fuscous or whitish. Labial palpi 4–4½, yellow-ochreous mixed with fuscous, beneath white towards base. Legs whitish, anterior tibiæ infuscated. Forewings rather elongate-triangular, costa gently arched, apex almost rectangular, termen slightly bowed, oblique; orange, variably mixed with reddish-fuscous or dark fuscous, especially on veins, in two specimens wholly suffused with fuscous; extreme costal edge sometimes whitish in middle; markings reddish-brown, mixed or suffused with dark grey; a suffusion along basal ¼ of costa, sometimes extending basally to dorsum; first line irregularly curved, second denticulate, forming a strong subquadrate loop inwards below middle, space between them wholly suffused with dark except along costa and on a band preceding upper half of second line; sometimes a sharply defined irregular transverse or rhomboidal clear white discal spot at middle, but in three specimens this is not indicated; a moderate terminal fascia, suffusedly projecting inwards opposite loop of second line: cilia dark grey, tips pale and reddish-tinged. Hindwings whitish-yellowish, becoming whitish towards costa; dorsal area more or less suffused with grey (in one specimen the whole wing grey except costa); two dark grey discal dots very obliquely placed; sometimes a grey postmedian line; a suffused dark grey terminal fascia, sometimes very narrow or obsolete except at apex; a terminal series of dark grey dots; cilia rosy-whitish, with an indistinct grey line.

Seven specimens. Very variable; nearest to *M. flavidalis*, but always without the yellow quadrate spot in middle of disc of forewings (always present in *flavidalis*), and also distinguished from both *flavidalis* and *marmarina* by the much longer palpi; readily separated from *notata* by the dark median band and terminal fascia.

### 12. *Scoparia*, sp.

One specimen of a species allied to *S. cyamenta*, but in very poor condition and unfit for determination.

### 13. *Scoparia leptophæa*, n. sp.

♀. 19–21 m.m. Head and thorax light fuscous, with some whitish scales. Labial palpi 3½, fuscous, white towards base beneath. Forewings very narrow, apex rounded-obtuse, termen obliquely rounded; fuscous-whitish, densely irrorated with fuscous and sprinkled with

dark fuscous; first and second lines formed by black irroration, very indistinct, first nearly straight, rather strongly oblique, second angulated above middle, indented beneath costa, followed on costa by a cloudy whitish spot; spots formed by black irroration, very undefined, orbicular remote from first line, claviform obliquely before orbicular, near first line, discal cloudy: cilia fuscous-whitish, with subbasal and postmedian cloudy fuscous lines. Hindwings $1\frac{3}{4}$, pale fuscous, becoming darker towards termen; cilia whitish, with fuscous basal line.

Seven specimens, all in bad condition. An obscure species, but quite distinct from anything else; by the form of the narrow forewings it is probably most allied to *S. psammitis*.

PTEROPHORIDÆ.

14. *Platyptilia axolodes*, n. sp.

♂ ♀. 17–22 m.m. Head, palpi, and thorax ochreous, variably mixed with whitish and reddish-fuscous, frontal tuft 1; palpi nearly 4. Middle tibiæ distinctly tufted in middle and at apex. Forewings with apex produced, termen prominently angulated on vein 3 (middle of second segment); reddish-brown, varying to light reddish-ochreous, variably mixed with whitish and dark fuscous; costa darker, strigulated with whitish; a dark reddish-brown subtriangular spot on costa at $\frac{2}{3}$, anteriorly undefined, its apex touching a blackish transverse dot before fissure, posteriorly followed by more or less ochreous-whitish suffusion; subterminal line sharply dentate, ochreous-whitish, usually nearly obsolete, but in one specimen in which the terminal area is suffused with dark reddish-brown very conspicuous: cilia reddish-fuscous, barred with whitish, on termen with tips beyond a blackish median line whitish, on dorsum with numerous small projections of black scales and a larger black scale-tooth at $\frac{2}{3}$. Hindwings fuscous: cilia whitish-fuscous, with indistinct darker median line on termen; on dorsum with rather large undefined black scale-tooth scarcely beyond middle of third segment, and numerous black-tipped projecting scales between this and base.

Six specimens. Varies considerably in colour; nearest allied to *P. falcatalis*, but smaller and darker, and readily distinguished by the prominent angulation of termen of second segment of forewings (in *falcatalis* the margin is somewhat bent but not angulated), and the principal dorsal scale-tuft of hindwings being hardly beyond the middle, whereas in *falcatalis* it is much broader and is considerably beyond the middle.

TORTRICIDÆ.

15. *Cacœcia excessana*, Walk.

Four specimens, showing considerable variation.

ŒCOPHORIDÆ.

16. *Borkhausenia* (*Œcophora*) *pseudospretella*, Stt.

Four specimens. Artificially introduced.

TINEIDÆ.

17. *Trichophaga tapetiella*, L.

One specimen. This and the two following species are also hangers-on of man, and have been brought in by him.

18. *Monopis ethelella*, Newm.

Six specimens; normal.

19. *Tinea terranea*, Butl.

Six specimens.

XVI. *On a new cricket of aquatic habits, found in Fiji by Professor Gustave Gilson.* By Professor Louis Compton Miall, F.R.S., and Professor Gustave Gilson.

[Read May 7th, 1902.]

Plates VII and VIII.

The aquatic cricket now to be described was obtained by Professor Gilson of Louvain in Viti-Levu, Fiji, on October 23rd, 1897. It was found on a branch of the Upper Navua river, a clear and rapid stream, flowing through a deep, rocky valley. Myriads of black specks were seen dancing on the surface of the water. When alarmed, they hid behind stones. They skated on the water, or jumped to a height of about six inches, usually several times in close succession, and were sometimes seen to leap upon very disturbed water. Now and then three or four of the crickets seemed to be playing at leap-frog, and jumping over one another, as if in sport. They were very hard to catch, though several men were employed in capturing them, and very few specimens were secured. Night interrupted the work, and next day an attack of malarial fever obliged Professor Gilson to desist. Rainy weather followed, the river rose, and no more was seen of the crickets.

The largest male specimen was 11 m.m. long, not including the antennæ, cerci, or wing-tips. In most respects the head resembles that of other Gryllidæ. The mandibles exhibit a peculiar structure, the masticatory surface consisting of three cutting ridges, alternating with molar surfaces, which are armed with close-set denticles (fig. 8). No ocelli were found. A pair of cerci project from the 7th abdominal segment.

The wing-covers of the male have the dorsal area largely membranous; the general arrangement of the veins is somewhat like that of the Gryllidæ in which the male stridulates, and altogether different from the venation of the female wing-cover. The roughened file, the chanterelle, the chords and the oblique veins are either

wanting or not functional, so that our cricket has no tambour in the sense of Saussure,* a fact which has some bearing upon its systematic position. It seems most probable that the wing-cover has been formerly adapted for stridulation (as in most male Trigonididæ) and that the power has subsequently been lost. The wings of the second pair resemble those of other Gryllidæ in their numerous radiating veins, which cover the whole surface; when folded, they project beyond the body like a pair of long tails.

The fore tibia has two auditory fenestræ and one terminal spur (fig. 13).† The tarsus is three-jointed, and the middle joint, which is short and heart-shaped, shows a very peculiar structure, viz. a fringe of rather long and close-set setæ, protected by a thin chitinous plate, which is perhaps double. A similar apparatus is found in the tarsus of the mid and hind legs also (figs. 10, 11); it is perhaps used as a comb for cleaning the body. From the tip of the basal joint of the tarsus stands off a stout spur, ending in a hook, and with one border serrated. The terminal joint in all the legs bears two pointed, laterally serrate claws. The mid leg differs from the fore leg chiefly in the absence of auditory fenestræ and the presence of two tibial spurs. The hind leg, as in other Gryllidæ, is adapted for leaping. The tibia of this leg bears three unequal spurs, two of which are serrate, and six articulated and setose spines, three internal and three external. The first tarsal joint bears two unequal spurs, one of which is serrate, the middle joint is short, heart-shaped, and provided with a comb, and the terminal joint, as in the other legs, bears two serrate claws. The hind leg greatly exceeds the others in length, and here only can we discover a special adaptation to leaping on water. The long and setose spines of the tibia are well fitted for striking the surface-film without breaking it. No very special modification for this purpose has been discovered in the mid and fore legs. It is possible, as every-day observation shows, for insects of small size, such as Nemoceran flies, to rest on the surface of water without possessing any

* Rech. Zool. du Méxique, VI, pp. 297, 309 ; Mélanges Orthopt., p. 513.

† The imperfect condition of the female specimens does not enable us to positively say that the fenestræ occur in that sex, as they almost certainly do ; they are wanting in the larva.

peculiar structure in the leg. Even the common house-cricket, though nearly twice as long as the aquatic cricket from Fiji, and many times heavier, does not sink in water, and can propel itself awkwardly upon the surface, though it cannot leap upon it.

It is well known that another genus of cricket (Tridactylus, placed by Saussure in the tribe of Gryllotalpidæ) is capable of leaping on water. Here the hind tibia bears two rows of articulated and flattened plates, four on one side and three on the other. From the extremity of the joint project two pairs of spurs and the rudimentary tarsus. Tridactylus differs so conspicuously from other crickets in the antennæ and wings that it cannot be supposed to be nearly related to our cricket, and the similarity in the hind tibia is no doubt purely adaptive.* In Scelymena, Serv., a genus of Tettigidæ, of which several species occur in Ceylon, Java and Burmah, the hind tibia ends in four strong, articulated spines, and the first tarsal joint may be dilated. These insects live on the margins of streams and ponds; some of them have been seen to leap on water.† Dr. Brunner von Wattenwyl tells us that several groups of Phasmidæ are known to him as possessing the same power. The long hairy spines of Pseudonemobius pictus (Gryllidæ) from Cashmere suggest that this insect also may leap upon water, but its habits have not been described. Certain Hemiptera, such as Gerris (Hydrometra) lacustris, and some Collembola, such as Podura aquatica and Isotoma palustris, can also leap upon water, a faculty which becomes less remarkable as the size of the insect diminishes. The Fijian cricket attains a length of 11 m.m., Tridactylus variegatus 6 m.m., Gerris lacustris 9 m.m., while neither of the Collembola exceeds 2 m.m.

The female insect differs most conspicuously from the male in the presence of a rather long, curved ovipositor, and in the quite different pattern of the wing-cover. The ovipositor resembles that of some other Trigonididæ.‡

The larva has no wings, no ovipositor, no auditory

* The mode of life of Tridactylus is carefully described by Saussure, Recherches, VI, pp. 321–3.

† Saussure, Études sur quelques Orthoptères du Musée de Genève; Ann. Soc. Ent. Fr., 4e sér., tom. I, pp. 467–494 (1861).

‡ Saussure, Mélanges Orthopt., tom. II, pp. 522-531, and Fig. LXXIX.

fenestræ, and only three articulated spines on the inner side of the tibia.

The aquatic cricket from Fiji agrees with the Trigonididæ among the tribes of Gryllidæ,* except in the number of the articulated spines of the hind tibia and the character of the male wing-cover. Saussure, who, of course, was unacquainted with this form, says (*loc. cit.*, p. 599), that in male Trigonididæ the elytra are sometimes devoid of tambour (stridulating apparatus), and are then identical with the elytra of the female; or they may be furnished with a complete and well-developed tambour. In our insect the male elytron or wing-cover differs greatly from that of the female, and yet is not completely equipped for stridulation. The ovipositor of the female closely resembles the peculiar ovipositor of Cyrtoxiphus,† and the partly coriaceous, partly membranous wing-covers, as well as the presence of two fenestræ in the fore tibia, also approximate it to the genus Cyrtoxiphus. Brunner von Wattenwyl ‡ has described a genus of Trigonididæ (Amusurgus), in which the male elytron has no tambour or stridulating organ, and the new Fijian cricket seems to come very near both to Amusurgus and to Cyrtoxiphus. Few details of the male elytron of Amusurgus are given, but it appears to differ from the same part in our cricket, being narrow and silky ("angusta, holosericea"). The hind tibia has four movable spines on each side.

It is necessary, we think, to place our aquatic cricket in the tribe Trigonididæ, where it will be distinguished by the male elytron being partly membranous and altogether unlike that of the female, but without functional stridulating organ, while the hind tibia bears two series of articulated spines. It seems necessary to recognize the genus as distinct, and we propose for it the name of *Hydropedeticus*.§ The species may be named *H. vitiensis*. Dr. Brunner von Wattenwyl, to whom we have submitted our description and drawings, tells us that he has no doubt of the correctness of the systematic position thus assigned to the new cricket from Fiji.

* Saussure, Mélanges Orthopt., tom. II, p. 185.

† *Ibid.*, p. 601.

‡ Rév. du Syst. des Orthoptères, 1893, pp. 207, 212.

§ Suggested by Mr. B. M. Connal, lecturer in Latin to the Yorkshire College. *Hydropedeticus* means *leaping on water*.

## Explanation of Plate VII.

Fig. 1. Male *Hydropedeticus*, the right wing-cover and wing extended × 3.

2. Left wing-cover of the male. The dorsal and lateral areas, which do not lie in the same plane, are drawn separately, a clear space intervening.

3. Right wing-cover of the female, the dorsal and lateral areas separated.

4. Tibia and tarsus of hind leg, showing the adaptation for leaping on water. Three of the spines are foreshortened, and their setæ are not shown.

5. Auditory fenestræ of fore tibia, superposed.

6. Immature *Hydropedeticus* (larva) × 3.

## Explanation of Plate VIII.

Fig. 7. Head of *Hydropedeticus* with antennæ, eyes and mouth-parts.

8. Edge of mandible, showing the cutting ridges alternating with molar surfaces.

9. Maxillæ and labium, seen from behind.

10. Middle tarsal joint of mid leg. To the right is seen the thin chitinous plate and the fringe of setæ.

11. The same part of the hind leg, with the smaller serrated spur of the basal joint.

12. The larger serrated spur of the basal tarsal joint (hind leg). Only the bases of the long setæ on the outer margin are shown.

13. Fore leg with auditory fenestra.

14. Mid leg.

15. Extremity of female abdomen in side-view, with one of the cerci and the ovipositor. A spiracle is seen between the dorsal and ventral plates.

XVII. *Five Years' Observations and Experiments* (1896—1901) *on the* Bionomics *of South African Insects, chiefly directed to the Investigation of* Mimicry *and* Warning Colours, by Guy A. K. Marshall, F.Z.S. With a Discussion of the Results and Other Subjects suggested by them, by Edward B. Poulton, M.A., D.Sc., F.R.S., Hope Professor of Zoology in the University of Oxford, Fellow of Jesus College, Oxford; and an Appendix containing Descriptions of New Species by Ernest E. Austen, William L. Distant, Colonel Charles T. Bingham, F.Z.S., Guy A. K. Marshall, and Jules Bourgeois.

[Read March 5, 1902.]

Plates IX. to XXIII.

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## I. INTRODUCTION.

### A. By Guy A. K. Marshall.

The observations and experiments which form the groundwork of the present memoir were originally undertaken by me at the instance of Prof. Poulton, and such interest as they may possess is largely due to his valuable suggestions and advice. Moreover he has been good enough to undertake the entire clerical work in connection with the publication of the paper, and he alone is responsible for the numerous excellent plates with which it is illustrated. The utility of experiments such as here recorded depends almost entirely upon the manner in which the results may be treated. The mere accumulation of facts of this kind has little real value, unless these facts are properly classified and co-ordinated, and their bearing upon current theories adequately considered and discussed. This portion of the work has been left almost entirely in Prof. Poulton's hands, and I feel that I am fortunate in having obtained his hearty co-operation; for his wide experience in this particular line of research insures a thorough treatment of the subject.

In carrying out the experiments I have always endeavoured, so far as in me lay, to record the results as impartially as possible. But on reviewing my experiences as a whole I cannot escape the conclusion that they lend very strong support to the theories of Mimicry and Warning Colours as enunciated by Bates, Fritz Müller, and Wallace; I feel convinced that were naturalists more ready to carry out extensive experiments of this nature there would be much less of the prevalent *a priori* criticism of these valuable theories which throw light upon a vast number of facts which must otherwise remain for us mere meaningless coincidences. It is especially important that experiments should be made by as many different observers as possible, for in this way alone can the errors due to unavoidable personal bias be eliminated; and if the present publication only has the effect of inducing other entomologists in South Africa, or elsewhere, to turn their attention to the interesting problems involved, it will have fully served its purpose.

G. A. K. M.

## B. By E. B. Poulton.

The following memoir has been written upon and around the great mass of valuable material supplied by Mr. Guy A. K. Marshall's observations, experiments, and captures from 1896 to 1901. So far as this material consists of specimens it is open to the study and criticism of all naturalists; for it has been placed by the generosity of Mr. Marshall in the bionomic series of the Hope Department in the Oxford University Museum. The paper itself has been gradually growing during these years, not only by the accumulation of specimens, but by an uninterrupted correspondence between Mr. Marshall and myself. Extracts from Mr. Marshall's letters form a very important part of the whole work, and it is only right to point out that they were not written for publication, and that any want of co-ordination or continuity is entirely due to this cause. At the time when they were selected and arranged for publication there was no prospect of Mr. Marshall's return to England, and I was anxious that as many naturalists as possible might have the opportunity of reading the observations and discussions from which I had learnt so much and received such great pleasure; and when eventually he did return the paper had been read. Although no attempt was made to alter or re-write these extracts, Mr. Marshall's presence in England has made an immense difference in the work. We have been able to discuss the general arrangement and illustration as well as the details of many obscure and difficult subjects. On several points he has written paragraphs which give a far higher value to the paper. Where the experience of the naturalist on the spot has been specially required it has become available. The sections of the paper under my own name have also greatly benefited by his kind assistance, and the opportunity of discussing points of special difficulty or uncertainty. It will be clear to all who read the paper that Mr. Marshall and I do not entirely agree in the interpretation of many facts, especially those connected with the seasonal phases of *Precis*, and in the extent and predominance of Müllerian mimicry as compared with Batesian in Lepidoptera. For these and other reasons it is necessary to state explicitly that I am solely responsible

for the opinions and considerations set forth in the sections to the titles of which the initials "E. B. P." are appended (in both the contents and the text). Mr. Marshall's numerous and important contributions to these sections are always acknowledged and placed between inverted commas. The titles of Mr. Marshall's sections are indicated by the initials "G. A. K. M.," and my contributions to these are always placed between square brackets, and are furthermore indicated by my initials.

Colonel J. W. Yerbury has kindly contributed one section and Colonel C. T. Bingham another, and both have given much help in other parts of the work. Some of the most strange and interesting insects were undescribed species, and would have been comparatively valueless for the purpose of this memoir, were it not for the kind assistance of the naturalists who have written the Appendix. Dr. F. A. Dixey kindly read the proofs and made many valuable suggestions and corrections. Mr. C. J. Gahan has given much kind assistance in the sections dealing with Coleoptera and in the identification of species. The number of species sent by Mr. Marshall is so large that the work of identification has been very laborious and prolonged, and we desire warmly to thank Sir George Hampson and the whole of the staff of the Insect Department of the British Museum, every one of whom has been consulted at one time or another. We also wish to thank heartily Colonel C. T. Bingham, who has named the whole of the Hymenoptera; Colonel J. W. Yerbury, who has worked out the majority of the Diptera; Mr. M. Jacoby, who has named many Phytophaga; Monsieur Jules Bourgeois, who has named the *Lycidæ*, and Mr. W. L. Distant, who has named the Hemiptera. Much other kind assistance has been given and is acknowledged in the text of the work.

Valuable material with excellent data, comparing in a most interesting manner with that sent by Mr. Marshall, was contributed from British East Africa by my kind friends Mr. and Mrs. S. L. Hinde.

The thirteen uncoloured plates are reproduced from excellent negatives taken from the actual specimens by Mr. Alfred Robinson in the Oxford University Museum. The two coloured plates are reproduced from Mr. Horace Knight's drawings of the specimens.

A brief abstract of some of the chief results here recorded

in detail was communicated to the Zoological Section of the British Association at Bradford (Report 1900, pp. 793–4), and an abstract of the present paper is printed in the Proceedings of the meeting at which it was read (Proc. Ent. Soc. Lond., 1902, pp. x—xiii). Some of the observations were also brought before the International Zoological Congress at Berlin, 1901 (Verhandlung, p. 171). Lists of the specimens presented to the Hope Department and a brief statement of the principles which they illustrate have been published yearly in the "Report of the Hope Professor of Zoology" communicated to the "Oxford University Gazette." Allusion to some of the material and the problems it illustrates, has also been made by the present writer in Linn. Soc. Journ. Zool., vol. xxvi, 1898, p. 558, and Report Brit. Assoc., 1897, p. 689. Much has been written upon the work on seasonal dimorphism in the genus *Precis*, but full references will be found in this section of the present paper.

The first part of the following work, occupying just half of it, deals with experiments and observations upon insectivorous animals, and the conclusions and considerations arising out of this work. The experiments on *Mantidæ*, Kestrels, and baboons will be found to be especially numerous and important. A table shows all the examples of *Asilidæ* and the species forming their prey which could be found recorded or preserved in the British Museum and Hope Collection. The direct and indirect evidence of the attacks of birds on butterflies meets objections which are often raised, and indeed nearly the whole of this part of the paper is an effective reply to those who ask for facts rather than hypotheses. One very important side of the work is the employment of Coleoptera on a large scale, and the clear evidence of aposematic and synaposematic colours in the group. A comparison between the Coleoptera and Lepidoptera in this respect is attempted. The first half of the memoir ends with a section discussing and criticizing the conclusion that there is any great significance or value in human experience of the taste and smell of insects.

The second half of the work is more heterogeneous. Its first section attempts to supply an interpretation of the startling seasonal phases of butterflies of the genus *Precis*. In this section Dr. A. G. Butler's convenient

terms "wet phase" and "dry phase" * are generally used in preference to "form" or "variety," while Mr. Marshall's useful sign ⊕ to indicate the former and ⊙ to indicate the latter are freely employed. The remainder of the paper is chiefly devoted to the description of an immense mass of material illustrating mimicry and common warning colours in Rhopalocera, Coleoptera, Hymenoptera, and to a less extent Hemiptera. Many interesting conclusions emerge and are discussed.

I entirely agree with Mr. Marshall's opinion that an unbiassed consideration of the facts presented in this paper yields a very strong measure of support to the classical theories of Bates, Wallace and Fritz Müller. I would go further and maintain that Mr. Marshall's observations and experiments here recorded, place Africa in the first position as the region which supplies stronger evidence than any other of the validity of these theories. But I am even more impressed by the strong support yielded to the modern developments of Fritz Müller's theory of mimicry. Where has Professor Meldola's Müllerian explanation in 1882 of the common facies of specially-protected subfamilies of butterflies received such illustration as in the groups of synaposematic *Acræinæ* captured in one place and at one time; or the extension in 1887 by the present writer of the same interpretation to the types of insect colour and pattern which are common to a country, received such support as in the marvellous group of Mashonaland insects of many Orders with an appearance founded upon that of the distasteful Coleopterous genus, *Lycus?* And the most recent developments of all, the discovery (1894–7) of the principle of "reciprocal mimicry" or "diaposematic resemblance," and of the specially close mimetic resemblance of the females in Müllerian mimicry no less than in Batesian by Dr. Dixey, together with his Müllerian interpretation of resemblances between mimics overlying their resemblance to a common model, all these, founded on the study of Neotropical forms, have supplied the explanation of numerous instances in the Ethopian Region although applied to very different families and

* The term "phase" is advantageous inasmuch as it is conveniently applicable to the whole of the winter or summer generations of a species, as well as to single individuals of either seasonal form.

sub-families of butterflies, to Coleoptera as well as to Lepidoptera.

I cannot conclude without warmly thanking my friend Mr. Marshall for the pleasure I have enjoyed in the work which we have done together.

E. B. P.

2. Experiments on Mantidæ in Natal and Rhodesia. (G. A. K. M.) *Natal, February* 1897.

I. Gave a wingless *Acræa horta* to a Mantis. It seized it and threw it away. On a second presentation it felt the butterfly carefully with its antennæ, then took it and began eating first the haustellum, then the palpi, and finally the whole head with apparent relish. On biting at the thorax, however, it threw it down with evident disgust and began wiping its mouth on its fore-legs as though to take away the taste. I again presented the butterfly, but the Mantis at first only ran away from it. At last it took it again and began eating the thorax, but quickly threw it down and would have nothing more to do with it.

II. Experiment *a*.—Caught a full-grown Mantis and put it in a large green gauze bag. In the afternoon put in a house-fly, which was not eaten that day, but was gone next morning. Then put in a wingless male *A. horta* (a bitter yellow juice exuded from the wing stumps). On perceiving it the Mantis ran towards it, seized it and made a bite at the back of the thorax, but started back as if in great surprise, and wiped his mouth on his front legs. He exhibited both fear and curiosity; for as the *Acræa* approached he edged away, just keeping far enough off to be able to touch it with the end of his long antennæ, and when the *Acræa* walked away he followed, still feeling it over. At this point I was called away, and on my return found that the *Acræa* had been eaten all except the head and apical half of the abdomen. Afterwards put into the bag the *Amauris echeria* which had been rejected by spider C (Experiment 13), and which was half dead. As the Mantis took no notice of it I left, but on inspection in the evening I found that this butterfly had been entirely devoured, only a few small fragments of wings and legs being left.

Experiment *b*.—Gave the Mantis a perfect male *A.*

*horta*. He tackled it at once, seizing it from above and biting the thorax, but he quickly let go and began wiping his mouth as before. A few minutes later he made a second attempt with the same result. After this he appeared to avoid it. I then put in a wingless *Amauris echeria* and left him for some time. On my return I found it had been entirely eaten, whereas the *A. horta* was still untouched. Took the *horta* out, cut off its wings and replaced it. The Mantis eyed it with suspicion whenever it came near him, and felt it cautiously with his antennæ; when it came too near him, he backed away and would not attempt to touch it. Later on I tapped the gauze so that the *horta* fell close by the Mantis. He gripped it at once, and began eating away at the underside of the abdomen, but soon threw it down again, and would not touch it although I gave him no other food for twenty-four hours. After that I put in a male *Belenois severina*, which he devoured readily.

Experiment *c*.—After starving the Mantis for twenty-four hours I gave him a *L. chrysippus*. On seeing it fluttering he came down to it eagerly and soon caught it. The large wings prevented him for some time from getting at the body, and he therefore ate away almost half a hind-wing. He then went on and ate the whole insect except the limbs.

Experiment *d*.—Gave the Mantis a *Papilio demodocus*. He had some difficulty in catching it at first, owing to its size and strength, but eventually seized it from below and devoured it.

Experiment *e*.—Gave an entire female *horta* to my captive Mantis. He caught it, bit the thorax and started back with disgust, just as in the previous experiment, but his efforts to get rid of the nasty taste were more prolonged. For over five minutes he continued cleaning his mouth on his fore-legs or rubbing it from side to side on the gauze. I then put in an entire *Amauris echeria*, but he seemed too scared to attempt to touch it. However, he caught it during the night (while there was a light in the room) and ate all the abdomen, leaving the head and thorax.

### Experiments on *Mantidæ* at Malvern, Natal.

III. On March 11, 1897, I captured a large female green Mantis [probably *Polyspilota aspera* (Westw.) or very

near it]. On the 12th I gave her an *A. petræa,* which she devoured entirely. On the 13th I gave her an *A. serena;* she seized it and ate a good piece out of one of the hind-wings. She then attacked the thorax, but after a few bites threw down the insect and began ejecting a brownish liquid from her mouth on to a leaf, and also wiped her mouth with her legs in the usual manner. A few moments after I put in a male *Hypolimnas misippus,* which she soon caught and ate. Later on I put in another *A. serena,* but she paid no attention to it. I then put in a *P. demodocus,* with the same result, so I removed them both. On the 14th I gave her no food. On the 15th I put in one *A. encedon* and one female *H. misippus,* but no attention was paid to either. I eventually removed *encedon,* leaving *misippus.* Later on put in *Eurytela hiarbas,* and left both in all night and through the next day, but the Mantis would not touch them. As it was beginning to show signs of weakness I released it.

IV. Experiment *a.*—March 25. Caught another female Mantis [probably the same species as the last], and gave her an *A. cabira,* which she quickly caught. She began by eating part of the fore-wing, but as she reached the base of the costa dropped it suddenly. A little later, while I was not watching, she took it up again and ate all the body except the head and anal segment. I then gave her a *Charaxes varanes* and a *P. demodocus,* which were both eaten immediately in succession.

Experiment *b.*—March 26. Gave the Mantis an *A. cabira.* The day being cloudy and cool, she was sluggish, and it was some time before the butterfly was caught. She missed the first two strokes, catching it at the third and eating it entirely.

Experiment *c.*—March 27. Gave one *A. encedon* to Mantis. It immediately flew right on to her, which seemed to frighten her considerably, and she did not attempt to catch it, but edged away when it approached. This continued for a quarter of an hour, so I took the *encedon* out and put in a *P. demodocus,* which was soon caught and eaten. Later on I put in a *Neptis agatha;* the Mantis seemed rather suspicious of it, but eventually caught and ate it. I then gave her a *Pentila tropicalis,* which she ate, including the whole of the two fore-wings. I then tried her again with the same specimen I had given her in the morning; she caught and ate it without

any signs of distaste. Subsequently gave her *Mylothris agathina*, which was also eaten.

Experiment *d*.—March 28. I gave a male *A. serena* to Mantis. After a few moments she caught it and ate a bit out of the wings, but soon threw it down. The butterfly at once walked straight back to her and was promptly caught again, and after a single bite was again rejected. On looking a few hours afterwards I found it had been eaten. I then gave her a *P. tropicalis* and an *Alæna amazoula*, both of which were eaten, the latter wings and all.

Experiment *e*.—March 29. I gave Mantis one *Eurytela hiarbas*, one *Pyrameis cardui*, one *Junonia clelia*. All were eaten.

Experiment *f*.—March 30. I put one male *A. serena*, one *P. demodocus*, one *N. agatha*, and one *P. tropicalis* into the Mantis' cage at the same time. They were caught and eaten in the order mentioned without any sign of distaste. Immediately after she had finished I put in a brilliant dark-blue moth with orange markings (*Eggbolis vaillantina*), which has a strong smell. To my surprise she completely demolished it, and then ate a second *P. demodocus*.

Experiment *g*.—March 31. Gave Mantis a *P. demodocus* in the morning, which she ate: in the afternoon gave her one *L. chrysippus*, which she ate without any ado, and immediately afterwards a female *H. misippus*. I then gave her an *Acræa natalica*, which she quickly seized, but on biting the thorax dropped it at once. For some time she paid no attention to it, but later on tried it again, biting a little out of the wings and then dropping it again; after which she had nothing more to do with it. Subsequently put in a *Papilio brasidas*, which was promptly eaten.

Experiment *h*.—April 1. In the morning gave Mantis an *A. serena*. She caught it, and after eating the apex of one fore-wing threw it down, but a few seconds after she caught it again, nibbled a bit out of the costa of fore-wing and again threw it down. After a short interval the butterfly walked past her, she seized it, bit at the thorax and at once rejected it. A few moments later she made a fourth attempt, this time eating half an antenna, but again found the taste too much for her. I then removed the butterfly and put in an *A. encedon*, but after nibbling a

small bit out of the wing she would have nothing more to do with it. In the afternoon I tried her with an *A. cabira*, which she also refused; I removed it and put in one *J. clelia* and one *P. brasidas*, but apparently the continued disappointments she had undergone disheartened her, for she would have nothing to do with either of them, but avoided them, and only tried to escape through the glass of the cage. About an hour after she ate the *brasidas*, but had not touched the *clelia* by sundown.

Experiment *i.*—For three days I fed the Mantis only on clearly edible species. On April 5, after eating two *P. demodocus* I gave her *L. chrysippus*, which she soon caught, but after eating a small portion of a hind-wing, she threw it down. A few seconds after, however, she caught and consumed all except the wings. She then ate a male *H. misippus*, and immediately after I put in a male and female *A. cabira*. The male was eaten at once; she then caught the female and ate a piece of the wing, but threw it down after the first bite at the thorax. The butterfly remained for a long time at the bottom of the box feigning death, so I put in another *L. chrysippus*. The movements of the latter disturbed the *cabira*, which was promptly seized by the Mantis, the abdomen being eaten but the thorax rejected. Shortly afterwards the *chrysippus* was caught and eaten from head to tail. Next morning as a sequel to this feast I found the Mantis in an apparently half-dead condition. The abdomen was much distended and no fæces had been passed for twenty-four hours. I therefore gave it no food whatever for two days. On the third day it seemed better and fæces were passed freely, but it still seemed very weak and refused food. Next day I found that it had lost all power of gripping with its fore-legs, so I fed it by hand on edible species. This I continued to do for several days, but it never properly recovered its strength, so I killed it.

V. Experiments on *Pseudocreobotra wahlbergi*, Stal.

1897.

Sept. 3. Lower Umkomaas River. Captured a male *P. wahlbergi*, and gave him an *Acræa cabira;* he nibbled a bit out of the wings, then ate the whole abdomen, but on

reaching the thorax rejected it, the butterfly having still sufficient vitality to flutter about.

Sept. 4. In the morning gave him an *M. safitza*, which he ate at once. In the afternoon put in an *Acræa encedon*, which he seized twice, but on eating a bit of the wing rejected; however, towards evening it was eaten.

„ 5. Gave him an *Acræa serena;* he seemed frightened at first and avoided it, but ate it about an hour afterwards. Put in another later, which remained untouched.

„ 6. The *serena* of yesterday was left uneaten all the morning. I therefore removed it and put in an *A. cabira*, which was also refused.

„ 7. In the morning removed the *cabira*, and put in another *serena*. As the *Pseudocreobotra* had not eaten it towards evening, I gave him an *M. safitza* in addition. He seemed to detect the difference, watching it immediately it was put in, and as soon as it came within striking distance, he seized and ate it, but still paid no attention to the *serena*.

„ 8. The *serena* remained uneaten all day, though from its appearance it had evidently been seized. In the afternoon put in a *Neptis agatha*. The Mantis avoided it at first just like the *Acræa*, but about an hour later I found it had been eaten.

„ 9–11. Wet days and no *Acræas* procurable.

„ 12. Gave Mantis an *M. safitza* and an *A. serena* at the same time; he seemed very frightened of both, avoiding them, or else striking at them in order to drive them away. Some hours later I found the *safitza* had been eaten entirely and a small piece out of the abdomen of the *Acræa*, which, however, was still quite lively.

„ 13. Gave Mantis two *A. serena* during the day, both of which were seized at once and eaten entirely from head to tail without any sign of distaste.

Sept. 15. Put in an *A. serena*. It was eaten after a short interval. Later gave him an *A. encedon*. At first he seemed only frightened, but subsequently caught it, and after taking a bite at the thorax threw it down and paid no further attention to it.

,, 16. Brought *Pseudocreobotra* from Umkomaas to Malvern.

,, 18. Put a *Teracolus omphale* and an *A. encedon* into his box, but they were not touched all day, owing to their inactivity and the large size of the box. The Mantis was also more sluggish in its movements than in a natural state.

,, 19. Caught the *encedon* and offered it to Mantis in my fingers. He objected strongly at first, but eventually took a small nibble but would not try another bite. Offered him the *omphale* in the same way, but being suspicious he refused it also, but at last took a bite, and, finding it all right, ate it all. On again putting the *encedon* near his mouth he only felt it with his palpi but would not eat.

,, 20. Left the same *encedon* in all day in hopes that he might be compelled to eat it by hunger; but he did not do so.

,, 21. *Encedon* untouched, so removed it and put *Pseudocreobotra* into a smaller box with the specimens of *A. serena*, but he seemed to take no interest in them. On holding one of the butterflies to his mouth, he felt it persistently with his palpi and seemed almost as though he were trying to eat but could not. He was certainly weaker on his legs.

,, 22. One of the *encedon* died during the night, and in the course of the morning I found the Mantis apparently eating at its head as it lay at the bottom of the box, without using his fore-legs, which were held out on each side. However, on taking up the butterfly I found he had made no impression on it. I then placed a *Terias brigitta*

close to his mouth, and he mumbled at it in the same manner without eating. It therefore seemed evident that his mandibles must have been paralyzed in some way, and on examination this proved to be the case, for they could be moved easily with a pin backwards and forwards, the insect clearly having no control over them whatever. The grip of the forelegs though noticeably weaker than normal was not completely lost, as in the previous experiment with a "Charaxes-eating" Mantis. I am inclined to think that the insect became at last partially blind, both from its actions and from the appearance of a small discoloured patch in the left eye, a symptom which also occurred in the "Charaxes-eating" Mantis.

The results of Experiment VI. practically negative the supposition that any of the above symptoms might be due to *insufficient* food.

### VI. Experiments on Leaf Mantis (*Phyllocrania insignis*, Westwood).

[One of Mr. Marshall's specimens was compared with the type of the above-named species in the Hope Collection.]

At the Lower Umkomaas River, during September, I kept two specimens of this insect for twelve and fourteen days respectively without a particle of food, and neither their vitality nor activity were in any way impaired at the end of that period. When captured they were in their pupal instar, and the final change took place on the 10th and 7th days respectively, both insects casting their skins in a normal and healthy manner in spite of their long fast.

### VII. Experiments on "Charaxes-eating" Mantis (*Polyspilota æffra*, Westwood, or very near this species).

1897.

Sept. 23. Caught, at Malvern, Natal, a "Charaxes-eating" Mantis (in the pupal stage), and gave him a *T. achine* and an *Acræa*

*serena* at the same time. He was somewhat wild at first, paying no attention to them but only trying to escape. Eventually he took the *achine* from my fingers and ate it, and later caught and ate the *Acræa*.

Sept. 24. Mantis ate a *Belenois severina*.

„ 25. Mantis ate two *Acræa encedon* without showing any signs of distaste.

„ 26. Gave him two *A. encedon*, but they were not eaten.

„ 27. Mantis ate one *encedon*.

„ 28. The second *encedon* dead. Put in four *Pardopsis punctatissima*, but no notice was taken of them.

„ 29. Mantis still refused to eat. Two *P. punctatissima* dead. Put in one *A. encedon*.

„ 30. One more *P. punctatissima* dead, and the remaining one was three-parts eaten, the *encedon* being left.

Oct. 1. Gave Mantis one *P. punctatissima* and one *A. serena* in addition, but he made no attempt to catch any of them, even when they settled quite close, merely feeling towards them with his antennæ; if they came too near he only ran away or else drove them off by striking out straight with his fore-legs. The discoloured patch in the left eye made its appearance on this day, and the sight on that side was evidently somewhat impaired. The legs also seemed to be weakening, and the grip of the front pair was not so strong as in normal specimens.

„ 2. No butterflies eaten, though I tried several times. I think that he may have been preparing for the final change of skin, which would account for his refusal to eat.

„ 3. Mantis attempted to perform the final ecdysis during the night, but owing to his bad state of health could not free himself properly from the old skin, being permanently deformed in a doubled-up

attitude when I first looked at him. I therefore killed him.

Judging from Experiment VI. the inability to change can hardly be attributed to weakness caused by want of food.

[In relation to the above-recorded experiments it is important to know the habits and natural food of the Mantis, and if possible to determine the species. Mr. Marshall kindly sent a specimen of an identical, or at any rate very closely-allied species, together with the following notes. —E. B. P.]

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—The Malvern species of Mantis is one of the largest out here, and I selected it as I knew it to be almost entirely a butterfly feeder. It frequents chiefly Acacias and their allies, and catches the *Charaxes* which come to suck the gum. Unfortunately they are scarce at Malvern, and I could not procure a single specimen during the winter, for I had hoped to make the very experiment you suggest, viz. feeding exclusively on Acræas or *L. chrysippus*. However, I caught two small Mantises on my arrival here (Umkomaas Mouth) yesterday, but I have not as yet even seen an *Acræa*."

"*Malvern, Oct.* 7, 1897.—I am not quite certain whether the Charaxes-eating Mantis sent is specifically identical with the one that died from *Acræa* diet. I thought it was the same in the pupal stage, but the imago of the latter has the upper wings entirely green, with a small yellowish spot about the middle. Unfortunately I have not been able to get one."

[The Mantis sent (captured at Malvern, Sept. 1897) was *Polyspilota aëra* (Westwood), of which the type is in the Hope Collection, Oxford.—E. B. P.]

VIII. Experiments with *Pseudocreobotra wahlbergi*, Stål, female.

1897.

Sept. 26. I captured at Malvern a full-grown female Ocellated Mantis, which ate a specimen of *Acræa encedon* during the day.

„ 27. Gave Mantis two *A. encedon*. She ate the thorax of one, rejecting the remainder.

„ 28. The remaining *encedon* died to-day. Removed it, and put in one *Acræa neobule*

and five *Pardopsis punctatissima*, but the Mantis would not touch any of them.

Sept. 29. Mantis still refused to eat, one *P. punctatissima* dead.

„ 30. Three more *punctatissima* dead. Mantis ate the *ncobule* entirely.

Oct. 1. The remaining *punctatissima* dead. Put in two *Acræa encedon* and one *A. serena*. The Mantis seemed more keenly alive to their presence than usual, eagerly following them in their flight with sharp turns of the head like a cat watching a swallow. At last the *serena* gave her a chance, and was immediately seized and eaten. No more were eaten during the day, and towards evening I put in another *A. serena*.

„ 2. The day being dull the three butterflies were quite inactive. I therefore placed the *serena* near the Mantis, which soon seized it, and ate nearly the whole of one fore-wing and part of the other; finding this unsatisfactory she dropped it. I then offered her an *encedon*, which was promptly taken and devoured entire, and immediately afterwards the *serena* was eaten.

„ 3. Wet day: no Acræas procurable. Remaining *encedon* dead.

„ 4. Gave Mantis two *A. encedon*. She was evidently hungry, on two occasions making futile jumps towards the butterflies as they fluttered past, instead of waiting for them to come within striking distance; there was however a noticeable decrease in her general vivacity. Eventually she caught both butterflies in quick succession, and devoured them completely. After the head of the second one was eaten, a large drop of yellow liquid oozed from the thorax. On tasting it she drew back quickly and seemed uncertain whether to go on or not, but finally put her mouth to it and sucked it all up,

though it appeared to me as if it were done under protest.

Oct. 5 6. No Acræas procurable.

„ 7. Put four *P. punctatissima* into her box at the same time. During the short time I was watching I saw her catch one or other of them no less than *seven* times, but on each occasion after the first nibble or two she threw it down with evident disgust.

„ 8. I was absent all day, but all the butterflies had evidently been further attacked by the Mantis, and small pieces had been eaten out of the fore-wings, but in no case had the bodies been damaged.

„ 9. Removed all the *punctatissima* and put in two *A. cabira* and one *A. encedon*, which were consumed entirely in quick succession. The Mantis appeared to show no decided symptoms of ill-health at present. I was unable to complete the experiment.

IX. First Experiment with Mantis. Salisbury.

1898.

March 2. Caught a pair of large green Mantis *in copulâ* [*Sphodromantis lineola*, Burm.].

„ 3. Gave them one *A. caldarena*, one *A. halali*, and one *A. neobule*, but they were all untouched.

„ 4. The *caldarena* had been caught and discarded, the thorax and one wing being partly eaten; removed the butterflies.

„ 5. Female Mantis ate the male. Put in two *caldarena* and one *induna*; Mantis tasted one of the former but quickly threw it down. During the day the other two were evidently caught and tasted, as they were both more or less damaged about the head and thorax.

„ 6. Mantis ate one *caldarena* and the *induna*; remaining *caldarena* died from injuries.

„ 7. Put in three *caldarena*, one of which was partially eaten.

March 8. One other *caldarena* completely eaten; the third died, its head having been partly eaten.

„ 9. Put in one female *halali* and one male, and one female *caldarena*. The former was soon caught, but after a few bites was rejected with evident disgust.

„ 10. Male *caldarena* eaten completely, female partially.

„ 12. Put in male *natalica*, one male and one female *caldarena;* the two former partially eaten. The latter was caught three times in quick succession, but promptly rejected on each occasion after the first bite.

„ 13. Put in a male *halali*, which the Mantis took at once, throwing it away after eating about half the thorax. Then gave her a male *caldarena*, which was completely eaten, so put in a second, which she promptly caught, but threw it down after the first bite at the thorax. She caught it again about a minute afterwards and started eating the apex of abdomen, but two bites were sufficient. A third attempt ended similarly.

„ 14. Saw Mantis seize and reject the same *caldarena* twice; removed it in the evening.

„ 16. Put in a male *caldarena*, which was completely eaten, but a second which I gave her immedately afterwards remained untouched. The Mantis began to show distinct signs of weakness, and I observed an opaque blackish spot in her left eye to-day for the first time.

„ 17. The male *caldarena* was killed to-day by a bite on the head. Mantis began to nibble off the end of one of her front tarsi, a sign that her end is not far off.

„ 18. Gave her a female *caldarena*, which was caught several times but not eaten. She continued to nibble at her tarsi.

„ 19. Mantis oviposited during the night, but the egg cocoon was only half as large as usual in this species [eggs proved to be infertile].

Gave her one male *halali* and two male *caldarena*. They were all caught in succession, but she only ate a very small piece out of each. At times she seemed very frightened of them, and in running away she twice fell upon her back, when she had some difficulty in righting herself owing to weakness.

March 20. Put in three male *caldarena*, one of which was caught and the whole of one fore-wing and part of the thorax eaten.

„ 21. Remaining two butterflies untouched. Mantis had by now eaten off the ends of all her tarsi except the anterior and intermediate on one side.

„ 22. In the afternoon I found the Mantis dead on her back.

X. Second Experiment with Mantis. Salisbury. 1898.

March 19. Caught a large green female Mantis of same species as previous one [*Sphodromantis lineola*, Burm.], and gave her one *Junonia cebrene* and three *Terias senegalensis*, all of which she ate. She also ate the following:—

„ 20. One *T. senegalensis*, one *T. brigitta*, one *Belenois severina*.

„ 21. One *J. cebrene*, one *Catochrysops osiris*.

„ 22. Two *Alæna amazoula*, without showing any signs of distaste.

„ 23. One *Spindasis natalensis*, two *J. cebrene*.

„ 24. One *T. senegalensis*, two *Myrina ficedula*.

„ 25. The Mantis escaped from the box this morning, and I did not find her till 5.30 p.m., when she was busy ovipositing on the side of a book. She had then laid about a third of her eggs, and did not stop laying till 8.30 p.m.

„ 26. Mantis ate one *Parosmodes icteria*, and two *Hesperia spio*. She seemed very hungry, following the butterflies about instead of waiting for them to come within striking distance.

March 27. She ate one *Catopsilia florella;* I then put in a *Belenois mesentina,* and she became much excited, running about after it, and making several futile snatches at it on the wing. At last she gave a vigorous stroke, and missing the butterfly caught the gauze with which the box was covered. Imagining apparently that she had caught her prey, she began trying to eat the gauze, in spite of my attempts to drive her away, for fully two or three minutes. At last she desisted and soon caught and devoured the butterfly, eating a *B. severina* and *Axiocerces harpax* immediately afterwards.

„ 28. One *Precis sesamus* and one *B. mesentina.*

„ 29. One *Hamanumida dædalus* and one *B. severina.*

„ 30. One *Pyrameis cardui* and one *B. mesentina.*

„ 31. One *J. cebrene* and two *B. severina.*

April 1. One *J. cebrene* and one *C. florella.*

„ 2. Two *C. florella* and one *P. cardui.*

„ 3. Mantis escaped. She was fully as vigorous and healthy on the last day as when first caught.

XI. Third Experiment with Mantis. Salisbury.

1898.

April 3. Captured a female Mantis closely allied to those of preceding experiments, being of same size and colouring, but having a much broader thorax and the mouth pink. This insect I submitted to a purely distasteful diet, combined with periods of starvation, as follows:—

„ 4. Three *Acræa caldarena* eaten.

„ 6. Two „ „ „

„ 7. Two „ *axina* „

„ 8. One „ *caldarena* „

„ 9. Two *Limnas chrysippus* „

„ 10. One „ „ „

„ 11. One „ „ „

„ 12. One „ „ „

April 16. One *Limnas chrysippus* eaten.
„ 20. One „ „ „ ; then left her a month entirely without food, which however did not seem to affect the health or vitality in any way.
May 19. One *Acræa axina* eaten.
„ 22. One *L. chrysippus* „
June 4. One „ „ „
„ 5. Two „ „ „ This insect never once exhibited the least signs of distaste for any of the butterflies, and devoured them all with avidity, showing a marked contrast to the Mantis first experimented with (IX.), which throughout exhibited an intense dislike to the Acræas, and evidently ate them from sheer hunger.

The close proximity of these two kinds of Mantis suggests the idea that they might possibly be seasonal forms of one species in which the winter form has adapted itself to an *Acræa* diet, owing to the comparative scarcity of other butterflies at that season. In spite of its diet and long fast, this Mantis was still fully as vigorous and healthy as when first captured.

„ 30. Ate one *L. chrysippus.*
July 8. Gave it two *Acræa axina ;* it tasted both of them several times, but in every case at once discarded them with evident disgust.
„ 22. Gave it two more *A. axina* with precisely the same result.
Aug. 21. Ate one *L. chrysippus.*
„ 22. „ „ „ „
„ 28. „ „ „ „
„ 29. „ two „ „
Sept. 4. Put in one *L. chrysippus.* The Mantis showed its normal eagerness, and followed it about for some time, finally attempting to seize it, but failed. The vigorous flutterings of the butterfly seemed to frighten the Mantis, which ran away from it and made no further attempt to catch it.
„ 5. Put in two more *chrysippus,* but Mantis

was still scared and would not go near them.

Sept. 8. Mantis died. There were no signs of ill-health as in former experiments, and the characteristic blotch in the eye was absent. Death was probably due either to hunger or natural causes. I only wonder at its lasting so long, considering its long fast and unhealthy food.

[The above experiments upon Mantidæ of four different genera are summarized as follows:—

Mantis I., in the Karkloof. Evident intense dislike, after trial, of *Acræa horta*.

Mantis II., male, in the Karkloof. Evident dislike of *A. horta*, although one specimen out of three was almost entirely eaten. Two *A. cacheria* were eaten, and one partially. One *L. chrysippus*, one *B. severina*, and one *P. demodocus* were eaten.

Mantis III., female, probably *Polyspilota caffra*, at Malvern. Ate one *A. petræa*, but rejected *A. serena* after trial. Ate one male *H. misippus*, but after this refused all butterflies, and exhibited signs of weakness.

Mantis IV., female, probably the same species, at Malvern. Ate *Papilios* and *Nymphalinæ* freely, including the probably aposematic genus *Neptis*, and the probably aposematic Lycænid genera *Alæna* and *Pentila*, and Pierine genus *Mylothris*. Ate *L. chrysippus* with hesitation, and partially in one case, freely in two cases. Hence the Mantis appeared to be a very general feeder on all butterflies except the genus *Acræa*, the species of which (*cabira*, *serena*, *encedon*) were rarely eaten until after one or more trials, and were sometimes finally refused. *Natalica* was only offered once, and rejected after trial. It is interesting to note that immediately after trial of three different Acræas, the Mantis refused species which she freely ate at other times. The final weakness without power of recovery was a probable result of the diet.

Mantis V., male, *Pseudocreobotra wahlbergi*, on the Lower Umkomaas River. Ate *M. safitza*, *T. omphale*, and *Neptis agatha* freely, the first-named on three occasions. *Acræa cabira*, refused twice; *encedon*, refused twice after trial and accepted once; *serena*, refused on five occasions, eaten on four. It is probable that the weakness and loss of sight was due to the *Acræa* diet.

Mantis VI., *Phyllocrania insignis*, on the Lower Umkomaas River. The evidence that starvation for twelve and fourteen days respectively does not produce the symptoms observed in Experiments III., IV., V., VII., and IX.

Mantis VII., male, in pupal stage, probably *Polyspilota caffra*, at Malvern. The Pierines *T. achine* and *B. severina* freely eaten. Of the Acræas, two *encedon* eaten apparently freely, and one after an interval, others refused: one *serena* eaten after a time: of four *punctatissima* only one partly eaten. The Mantis then refused all food, became weak, and one eye was affected. He was unable to throw off the pupal skin properly. In Experiment VI. two individuals of another species performed this change of skin after ten and seven days of starvation.

Mantis VIII., female, *Pseudocreobotra wahlbergi*, at Malvern. Only offered Acræas. Nine *punctatissima* always refused with or without trial: *encedon* eaten freely several times, refused once, and partly eaten once: two *cabira* eaten freely; *serena* eaten freely or after trial; *neobule* eaten after two days' interval.

In spite of this diet the Mantis remained apparently healthy, September 26 to October 9, 1897, when the experiment came to an end.

Mantis IX., female, *Sphodromantis lineola*, at Salisbury. It was intended to offer this individual a purely *Acræa* diet, but she ate her mate on the third day after their capture *in copulâ*. She was chiefly fed upon *Acræa caldarena*, which she ate sometimes freely, sometimes after an interval and after trials: at other times she refused it with or without trial; one *induna* was eaten after a day's interval; one *neobule* was untouched; one *natalica* was partly eaten: two *lualui* were rejected after trial, one without. After a fortnight of this diet the Mantis became weak, and her left eye was affected: a day later she began to nibble off the end of one of her fore tarsi: two days later she oviposited, but the egg cocoon was only half its usual size (eggs infertile). After the first signs of weakness the Mantis ate only a small part of three Acræas out of eight offered her during six days. She continued to nibble at her tarsi, lost power over her movements, and died after twenty days of captivity.

Mantis X., female, *Sphodromantis lineola*, Salisbury. This individual was the subject of a control experiment, being fed solely upon several species of the following groups

—*Nymphalinæ*, *Pierinæ*, *Lycænidæ*, and *Hesperidæ*. The only species with marked aposematic colouring and habits was the Lycænid *Alæna amazoula*, and of this only two specimens were offered, both being eaten freely. After fifteen days of this diet the Mantis escaped: she was then as healthy and vigorous as when first captured.

Mantis XI., female, species resembling *Sphodromantis lineola*, Salisbury. Fed solely upon *Acræa caldarena* and *A. axina*, and *Limnas chrysippus*, with long periods of starvation, two of them a month in duration. Seventeen *chrysippus*, six *caldarena*, and three *axina* were eaten without any signs of distaste, while four *axina* were discarded after tasting several times. The Mantis was captured on April 3, 1898, and refused food on September 4, dying on September 8 without signs of ill-health or blindness. Mr. Marshall suggests that the species may be a winter form (possibly of *S. lineola*) specially adapted to eat Acræas when other butterflies are scarce.—E. B. P.]

### 3. Conclusions from Experiments on Mantidæ. (E. B. P.)

Certain conclusions stand out very clearly, while others are suggested as probable. These voracious insects did not show any dislike of butterflies outside the *Danainæ* and *Acræinæ*. The undoubtedly aposematic Pierine genus *Mylothris* was freely eaten, and so were the following genera with probable warning colours, movements, and attitudes—*Neptis*, *Alæna*, *Pentila*, and the moth *Egybolis vaillantina*. Even the *Danainæ* were generally eaten without hesitation (II., IV., XI.), and never rejected altogether. In marked contrast was the behaviour of *Mantidæ* towards *Acræinæ*, which were constantly refused, and often eaten only after one or more trials and long intervals of time. When the Acræas were eaten freely and without hesitation there is reason for suspecting exceptional hunger. The summary of experiments shows very clearly that "*Pardopsis* appears to be considerably more distasteful. . . . than the general run of Acræas" (G. A. K. M., October 7, 1897, Malvern). There were also less marked differences in the degree of dislike shown towards other species; thus *axina* was less freely eaten than *caldarena* (XI.); *caldarena* appeared to be eaten more freely than *halali*, *neobule*, *induna*, and *natalica*

(IX.), although the number offered of these latter was insufficient to warrant a certain conclusion; *cabira* was rejected while a considerable proportion of the *encedon* and *serena* were accepted (V.); *horta* evidently possesses a high degree of unpalatability to *Mantidæ* (I., II.).

Mr. Marshall's evidence, by far the most important collected in the case of the *Mantidæ*, is in entire accord with the few observations which had been previously recorded. Thus the late Mr. de Nicéville found that *Acræa violæ* was the only butterfly refused by all the species of *Mantis* with which he experimented in the East ("Butterflies of India, Burmah, and Ceylon," vol. i, pt. ii, p. 318). Colonel J. W. Yerbury informs me that he watched the Mantis *Gongylus gongyloides* hanging from the drooping lavender flowers of a species of Duranta at Trinkomali (1890–91), and capturing the butterflies which were attracted by the bloom. The insect hung by its four posterior legs, with head thrown back and predaceous legs held ready for striking. He saw it capture and eat *Delias eucharis* on several occasions, and also *Belenois mesentina* and the Hesperid *Hasora alexis* (Fab.). Colonel C. T. Bingham has also given me a male specimen of the Harpagid Mantis, *Creobotra urbana* (Fab.), found by him on a Lantana bush actually eating *Delias descombesi* (Boisd.). This observation was made in the North Shan States, Upper Burma, on October 9, 1900. The fact that two species of *Delias* were thus freely eaten compares in an interesting manner with the acceptance of *Mylothris* by the African species of *Mantis*. We may safely conclude that outside the *Acræinæ*, and doubtfully the *Danainæ*, *Mantidæ* devour butterflies very freely, the species with warning colours as well as the others, and that they are far more undiscriminating than the majority of vertebrate insect-eaters. Thus Mr. F. Finn found *Delias eucharis* to be one of the most distasteful of all butterflies to many species of Indian birds ("Journ. Asiat. Soc. Beng.," vol. lxvii, Pl. ii, No. 4, 1897, p. 667). Mr. Finn also found in East Africa that a moth of the genus *Eggbolis* (*E. vaillantina*) was refused by a Chamæleon and a Gecko ("Natural Science," vol i, No. 10, Dec. 1892, p. 747). It is of deep interest to find such marked differences between the preferences of the various groups of insect-eating animals.

In addition to the observations recorded above, Dr.

David Sharp, F.R.S., quotes Mr. F. Muir concerning the food of *Idolum diabolicum* (Sauss.) at Mozambique :—"Its food seemed to consist of flies, *Limnas chrysippus* being rejected, even when hungry, and other butterflies only taken for lack of other food" (Proc. Cambr. Phil. Soc., vol. x, pt. iii, p. 175). Mr. Edward Barlow (Proc. Asiat. Soc. Bengal, Dec. 1894) states that *Hierodula bipapilla* (Serv.), kept in captivity at Calcutta, ate ordinary flies (*Musca* sp.) with avidity, but attacked with great reluctance the common large green blowfly (*Lucilia* sp.), only eating them when they could get nothing else. Two bugs, *Cyclopetia* sp. and *Physomerus* sp., offered when the Mantis was very hungry were never eaten, although often killed. After tasting the former, the Mantis wiped its mouth against its right fore-leg several times. This last observation is the only record I have found of Hemiptera offered as food to *Mantidæ*.

The question arises as to whether the preferences exhibited by *Mantidæ* in captivity are the same as those which exist in the wild state. A Mantis is probably less affected in this respect by confinement than a vertebrate animal; but the same general criticism will probably hold in both cases—that while the rejection of an insect by a not over-fed insectivorous animal in captivity is evidence of unpalatability or dislike, its acceptance is not sufficient evidence of appreciation or that it constitutes an element of the normal diet. An insect may be eaten readily in captivity which would be rejected or only eaten under the stress of hunger in the wild state; for it is generally quite impossible to supply an animal under artificial conditions with the variety and often the quantity of insects which it would catch for itself. In this respect a large Mantis can be kept in a more normal condition than an insectivorous vertebrate, because of the much larger amount of food required by the latter; although the young Mantis would offer great difficulties to the breeder, because of the vast numbers of very minute insects which it would require. But Mr. Marshall's experiments yielded plenty of evidence of the positive refusal and acceptance, as it were under protest, of *Acræinæ*, so that there can be no doubt of their distastefulness to this class of enemy, although acceptance might under the circumstances have not been convincing proof of their palatability. It is however in every way satisfactory to obtain evidence

from the behaviour of *Mantidæ* in the wild state, and such as we do possess entirely confirms the conclusions to be drawn from Mr. Marshall's experiments. In the first place we have the following observation of his own, made in the Karkloof, Natal, in February 1897 :—

"Saw a Mantis catch a male *horta* on a flower in the veldt. It began eating at the base of the abdomen, which it consumed entirely, and then started on the thorax, of which it only ate a very little, and then threw it away."

This observation corresponds almost precisely with many made upon the captive insects. Mr. Roland Trimen also says that he never found the wings of *Danais* or *Acræa* among the fragments of butterflies which sprinkle the ground below the feeding-place of a large Mantis, although he is careful to add that he could not be sure that these butterflies visited the exudations of Acacia sap, round which the predaceous insects secure a plentiful supply of food (Linn. Soc. Trans., vol. xxvi, 1870, p. 500). It has already been pointed out that Colonel Yerbury's and Colonel Bingham's observations upon *Mantidæ* in the wild state are entirely confirmatory of Mr. Marshall's observations of them in captivity, as regards the food which appears to be freely provided by certain Pierine genera refused or disliked by other insect-eating animals.

Another question of deep interest raised by Mr. Marshall's experiments on *Mantidæ* is the inquiry how far the species which they reject or eat only sparingly is unwholesome or even poisonous to them. There is strong *à priori* probability for the view that the preferential appetite of such a form as a Mantis is merely the strong instinctive tendency to eat the food which best suits its organization and reject that which suits it least. We should expect therefore that such marked disinclination to eat Acræas as we observe in *Mantidæ* indicates, not distaste or unpalatability in an anthropomorphic sense, but merely that Acræas are unwholesome to *Mantidæ*. The evidence requires to be sifted in detail.

In Experiment III. the signs of weakness seem to be a too-excessive result of the single *Acræa*, and portion of another, which were eaten. At the same time generic and specific differences are almost certainly of great importance, and it must be remembered that III., IV., and VII. belonged to probably the same species, and all exhibited weakness after an *Acræa* diet, resulting in the death of

IV., the deformity of VII., while III. was released. Experiments V. and VIII. were also upon the same species of Mantis. The first, a male, became weak and probably blind after eating a few Acræas; the second, a female, remained apparently healthy after an exclusively Acræine diet for fourteen days. It is very unfortunate that this latter experiment could not be continued. It is, however, clear that in the case of this species and sex a purely Acræine diet for fourteen days is not necessarily unwholesome. Experiments IX., X., and XI. were upon species which were the same, or nearly the same, and all females. The first died after an *Acræa* diet for twenty days, the second was perfectly healthy after a mixed butterfly diet without *Acræinæ* and *Danainæ* for fifteen days, while the third lived healthily from April 3 to September 8 upon Acræas and *Limnas chrysippus*. The latter seems to be an insuperable difficulty, but it must be remembered (1) that *chrysippus* was given in especially large numbers, and there is no evidence that *Danainæ* are much rejected by *Mantidæ*, (2) that the Mantis may have recovered from the effect of the Acræas during the long fasts, (3) that the *Acræa* chiefly made use of, *A. caldarena*, may be less unwholesome than the majority of the group.

More experiments are greatly wanted, but Mr. Marshall's observations render it highly probable that Acræas are unwholesome to *Mantidæ*. The definiteness of the symptoms exhibited, and especially the effect upon the eye, constitute not unimportant evidence in support of this conclusion. The appearance of an opaque blotch in the left eye of three of the Mantises (V., VII., IX.) suggests further experiments in order to test whether we have to do with mere coincidence or a phenomenon of deeper significance.

Mr. Marshall's conclusions from his experiments were written upon the results obtained with spiders as well as Mantises, and will be found at the end of the section upon the former (p. 322).

### 4. Experiments on Spiders in the Karkloof. (G. A. K. M.) *Natal, February* 1897.

[The Rev. O. Pickard-Cambridge, F.R.S., informs me that the species made use of was the common and widely-distributed Epeirid *Nephilengys malabarensis*, Walck.—E. B. P.]

The spiders experimented on were all of one species with very large females and minute males. Their webs were all round the verandah, where they were strictly preserved by Mr. Ball. I never saw the species in the bush.

1. Gave a spider (A) a specimen of *Acræa horta* (entire); she ran down and bit the thorax, then pulled it out of the web and dropped it. At the same time gave *A. horta* with its wings cut off to another spider (C) of the same species, which ate it without hesitation.

2. Gave *horta* without wings to four spiders (A, B, D, and E), and also one in which half the wings had been cut off to C. All were eaten readily.

3. Gave entire males of *horta* to A and B, and both were at once rejected.

4. Wingless specimens of *L. chrysippus* given to A and C were at once thrown out of their webs.

5. The following wingless specimens were given to this species:—*Papilio brasidas* to A, *P. ophidicephalus* to B, *P. euphranor* to C, *P. ophidicephalus* to D, *Eurytela hiarbas* to E, and *P. lyæus* to F. All of them were promptly eaten.

6. Caught a female *horta*, rubbed all the colour off its wings, leaving them entire, and gave it to A, which after careful examination wrapped it up and carried it off to eat.

7. Gave A a perfect male *horta*; she ran down and bit it in the thorax and ejected it from the web. I then rubbed all the colour off the wings and returned it. The spider approached it carefully feeling round with her palpi, and again cut the butterfly loose. I then gave it to B, which also refused it. I then cut the wings off and gave it to B again, with the same result. Finally I gave it to A again, but she pulled it out of the web by the abdomen and dropped it.

8. Gave wingless specimens of *Papilio demodocus* to B and C. Both were eaten.

9. Gave a perfect female *horta* to D, which bit it several times, being seemingly rather doubtful about it, but eventually wrapped it up and carried it off to her chamber. After a short time she threw it down, the butterfly being still alive.

10. On two occasions saw dead specimens of *A. horta* in spiders' webs in the bush. They were both wrapped up, but evidently had not been sucked.

11. Cut off the wings of three male *horta* and gave them to A, B, and C, but they were all rejected. Gave one of the same specimens to D, which carried it off to eat, and was still sucking it when observed two and a half hours afterwards.

12. Gave a wingless *Amauris echeria* to A, which came down very cautiously and bit it in the thorax as usual. Its taste was evidently unpleasant, as in extricating the butterfly from the web it carefully abstained from biting any part of the body. I then put the same specimen in B's web; she ran down at once and tackled it. After giving it a few bites she paused as though in doubt, then, as if thinking it was worth trying, she wrapped it up and drew it up after her to her chamber. She was clearly still doubtful, as she remained several minutes without attempting to touch it. She then sucked it for a few seconds, but soon let it drop. Gave the same specimen to D, and it was rejected. Gave another wingless specimen to C, which also was rejected.

13. Gave entire specimens of *Terias brigitta* to B, C, and D, and also female *Nepheronia argia* (*agathina* form) to A. All were eaten readily. Subsequently gave entire *P. sesamus* (*natalensis* form) to C, which was also eaten.

14. Gave a perfect male *horta* to D. She ran down, bit it in the thorax as usual, wrapped it up and carried it off. She then remained some minutes without attempting to touch it, then after sucking it for a few seconds she threw it away. (Compare Experiments 9 and 11.)

15. Gave a wingless *Acræa violarum* to spiders B, C, and D, in succession. It was promptly ejected by each of them.

16. Gave entire specimens of *A. horta* to spiders A, B, C, and D. The two former ejected theirs at once; C cut hers loose from the web, and was holding it in her jaws preparatory to throwing it away, when she seemed suddenly to change her mind and ran up to her chamber with it, without however enshrouding it with web. She remained with it in her mouth for about half a minute, and then threw it down. D took no notice whatever of the insect in her web.

17. Gave male *Acræa buxtoni* to A, and female *Nepheronia argia* (*agathina* form) to C. Both were eaten.

18. Gave *Pontia hellica* to B, *Papilio demodocus* to C, and

*Planema esebria* to D. All of them were eaten, though D seemed a little suspicious at first.

19. Gave *Byblia goetzius-achcloia* to A, which ate it readily, although she was a long time before coming down to see what it was.

20. Gave wingless specimens of *A. horta* to spiders A, B, C, and D (six days since last were given—Experiment 16). The first three promptly ejected them, but D wrapped hers up and carried it off. She did not seem very enthusiastic about it however, for she turned it over and over a good many times, giving it a bite here and there, and then left it alone for some time. This procedure she repeated several times, and then threw it away.

21. Gave entire males of *Acræa serena-buxtoni* to spiders A, C, and D, all of which were eaten. It should be noted that experiments with this species are unsatisfactory, owing to the fact that when captured it is able voluntarily to exude from the thorax its bitter yellow juice, and therefore when given to spiders it has lost much of its nauseous quality, and would be less distasteful than if caught by them direct.

5. Results of Experiments on Spiders and the earlier Experiments on Mantidæ: One probable meaning of tenacity of Life in distasteful Insects. (G. A. K. M.)

*Malvern, Natal; February* 21, 1897.—The danger of arguing from insufficient materials was clearly shown me in my first few experiments on spiders with *A. horta* (Experiments 1, 2, 3, and 6). When I had got thus far I felt sure I had got proofs of the appreciation of warning colours by the spiders. For in these experiments they ate every specimen without wings and refused all those with them except one which had the colour rubbed off. Yet subsequent experiments have convinced me that both spiders and Mantises have no appreciation of warning colours; and this fact has elucidated another which often puzzled me, I mean the apparently constant correlation between distastefulness and tenacity of life in Lepidoptera. At first sight it would seem that tenacity of life or the power to recover after severe injury would be useful to any species in the struggle for existence. But a little thought showed me that this power would be of no use to edible species, as if once caught by insectivorous animals

they are not likely to be released. But in the case of inedible species it is different. For if my surmise is true, that insectivorous invertebrates are not capable of appreciating warning colours but have to taste *all* their captives before being able to tell whether they are edible or not (which I think is clear from my experiments), then tenacity of life (as a protective agency) will be as useful an acquisition against invertebrates as warning coloration is against vertebrates, and come into play when the latter is useless. Of course tenacity is of use against the experimental tasting of young birds, lizards etc., but this does not seem to me to be a sufficiently cogent factor to develop the power to such a high pitch. For if the insects had only these enemies to contend against, even supposing every specimen experimentally tasted died from its injuries, the protection afforded by the warning colours would still be ample. Indeed I believe that the toughness of inedible insects has been primarily developed to counteract the injuries from invertebrate foes (which are incapable of reasoning as to whether an insect is edible or not), and that therein lies its chief utility, though it may prove useful incidentally in other cases.

*A. buxtoni* appears to have more juice in proportion than *horta*, and I regard it as a more highly-developed species, from a distasteful point of view, in that it can exude juice at will from its thorax, and thus show its nauseous qualities without necessarily having to be injured like *horta*. When squeezed the juice often oozes from the ends of the antennæ and all the nervures of the fore-wings when they are cut. But, as I have pointed out (*vide* Expt. 21), the results of experiments with it are unreliable.

The treatment of *A. horta* by the spiders would almost give some colour to your suggestion that the inedibility of species may be due to unpleasant internal effects rather than the mere taste, for B ate one specimen and A, C, and D two each before they seemed to become aware that it was not good to eat, from which I should conclude either that the unpleasant effects are subsequent to eating or that their sense of taste is not sufficiently acute to recognize a nasty flavour at once. But the latter conclusion appears to be invalidated by their prompt rejection of *L. chrysippus* and *A. echeria*. Anyway their selection seems to show that there are grades of unpleasantness, and, as I

expected, those species in which the sexes are alike are least edible. Thus I expect to find that *A. anemosa*, *A. cabira*, and *P. aganice* will prove more distasteful than their allies in which the sexes differ markedly. However, I must admit that in the case of the Mantis this was not so, and its persistent preference for *echeria* rather than *horta* (on three occasions) is very curious and interesting. Its dislike of the taste of *horta* was most marked, and yet it did not appear to distinguish it by sight. In Experiment II. *c* (p. 298) the Mantis certainly avoided *horta* after its first taste, but it showed equal fear of *echeria*, which it afterwards ate, and I presume could not distinguish between them. But it is clear that it was unable to retain long the impression which connected a butterfly with an unpleasant taste. The prompt acceptance of *A. serena* by the spiders appears to support my view that the bright red colour conveys no significance to them, although they find the red *horta* distasteful. I was surprised at their unanimous refusal of the single specimen of *A. violarum* I was able to procure, as I had thought it would certainly be more edible than *horta*, and I am almost inclined to believe that it was rejected under a misapprehension.

I had an idea that perhaps *Papilio demodocus* was distasteful, which was suggested by its wide range and general abundance; and that if this were so it would be probable *P. ophidicephalus*, *P. euphranor*, *P. constantinus*, etc., might obtain protection from their strong resemblance to it on the wing. But my experiments seem to negative the idea as far as invertebrate foes are concerned.

Again, *Terias* has always puzzled me. They are so widely distributed and always plentiful; moreover, their flight is weak and their contrasting colours of black and yellow are most conspicuous on the open veldt, which they frequent; indeed, far more so than the colours of the females of *A. violarum* and *acuara*. Yet they do not seem to be protected, although some of the tropical *Danaidæ* and *Teriomimæ* appear to mimic them.

*Malvern, Natal; Oct.* 7, 1897.—The experiments on the effects of an *Acræa* diet, so far as they go, seem to lend some measure of support to your view as to the unwholesome qualities of *Acræa*, though many more experiments will be necessary to establish it. If I could only get the material I should like to experiment contemporaneously on a number of the same species, starving one,

giving one or two only edible butterflies, and confining the remainder to a single species of *Acræa* or *Amauris* each. But at present I find it not only difficult to get hold of a Mantis, but it is even quite a job to catch sufficient Acræas to continue the experiments. I have not seen a single specimen of *A. petræa* for over six weeks, though normally it should be swarming at this time of year.

[Mr. Marshall subsequently carried out a part of the programme which he here suggests. See Experiments IX., X., XI. on *Mantidæ*.]

When the experiments on spiders are compared with those on Mantises the conclusion is suggested that *Acræinæ* were distasteful to both, and only eaten under the stress of hunger, while *Danainæ* were far less distasteful to the Mantises than to the spiders. To the latter they appeared to be at least as distasteful as the *Acræinæ*. Such differences in the susceptibilities of insect-eaters help us to understand the puzzling case of *Terias*, and the Ethiopian Lycænid genera which appear undoubtedly to mimic it, and permit us still to look on *Papilio demodocus* as a possible model. We see that the various insectivorous groups have different tastes, and within each group we must expect to find individual species adapted to feed largely on insects which are as a rule rejected by the other members of the same group.

In one respect spiders are extremely satisfactory for the purpose of these experiments. They remain throughout wild animals with their natural sources of food still available. The same may be the case with Mantides, as in the *Gongylus* watched day after day by Col. Yerbury at Trinkomali (see p. 316).

The late Thomas Belt ("Naturalist in Nicaragua," London, 1888, p. 317) states that a "spider that frequented flowers seemed to be fond of" the *Heliconidæ* (including *Ithomiinæ*), although a large species of *Nephila* used to drop them out of its web when he put them into it.

Dr. A. G. Butler (Trans. Ent. Soc. Lond., 1869, p. 27) long ago showed that the larvæ of *Abraxas grossulariata* and *Halia wavaria* were not eaten by the spiders he employed —*Epeira diadema* (the name given in the paper is *Ereiba diadema*) and *Lycosa* species (?). In the former case they were cut out of the web, and in the latter seized and carried down the "dark silken funnel," but then relinquished apparently uninjured. Professor Plateau (Mém.

de la Soc. Zool. de France, tome vii, 1894, p. 375) gives reasons for doubting whether the latter spider belonged to the genus named by Dr. Butler, and he supposes from the described form of "funnel" that the "*Lycosa*," which does not make a web, was in reality *Agelena labyrinthica*. Professor Plateau's fresh experiments (l. c. § 8) on spiders, however, entirely confirm the results obtained by Dr. Butler so far as the larva of *Abraxas* is concerned. An *Amaurobius ferox*, which had spun a characteristic web in captivity, paid no attention during two days to three half-grown larvæ moving about and entangled in the web. From the Professor's long experience of spiders in captivity he is confident that it was not afraid, and he thinks it probable that it refrained from attack because the vibration of the web was not like that caused by its habitual prey. It would have been more satisfactory if this interpretation had been tested by the offer of a few inconspicuous larvæ. In the next experiment four larvæ were thrown into a large web spun by a female *Tegenaria domestica* over the roof-light of a barn in such a position that the observer could watch everything without in the least disturbing the spider. The following is a translation of Professor Plateau's account:—"At the moment of the fall of the larvæ into the web, the *Tegenaria* . . . . rushes at one of them and bites it, or at least makes two successive attempts to bite it. The spider then leaves the first victim and attacks a second, which she also tries to bite, but the skin of the larvæ being too tough and the caterpillars rolled up and pretending to be dead, she retires *slowly*, a certain proof to those who know the habits of these animals that she does not feel any fear." Afterwards, when the caterpillar began to move the web, the spider, "having learnt the uselessness of her attempts to bite, neglects them entirely and remains in her tube."

Concerning this and the previous interpretation, it is necessary to remark that no signs of fear were to be expected upon the hypothesis that the spider recognized that the larva was uneatable; while the suggestion that the skin was too tough to be penetrated seems to be very improbable.

An experiment of the same kind was then made with a female *Tegenaria*, which spun a web in confinement. After keeping the spider for three days without food, two caterpillars were thrown into the web. The spider rushed

towards one of them but retreated again, "recognizing that it had been disturbed by a creature such as had never before fallen into the web." The same thing was again repeated on four occasions, the spider never actually attacking a caterpillar. *Agelena labyrinthica* was then tried in the same way, but would not leave its retreat; when, however, an earwig was substituted for the larva, it was instantly seized and devoured.

On the other hand, Professor Plateau has produced evidence that the imago of the *Abraxas* is freely eaten by *Tegenaria domestica*. Nearly every day for some weeks he placed this moth, sometimes on one, sometimes on another of three or four webs of this spider spun in a little tool-house in his garden. They were always seized and carried off.

*Agelena labyrinthica*, on the other hand, killed the moth but abandoned it after some attempts to suck its juices. Professor Plateau suggests that the spider found the prey too large for it, an interpretation which might have been advanced had the attempt to capture and kill been unsuccessful; but, as the case stands, serves to show that the author is willing to accept any explanation however improbable rather than the obvious one that there was something in the taste or smell of the moth which prevented the spider from devouring it.

A half-grown female *Epeira diadema* devoured the moth with avidity. It is to be hoped that this experiment will be repeated many times, as in the case of the *Tegenaria;* and in all such researches comparison should be constantly made with the behaviour of the spiders towards many other kinds of insects.

It is quite probable from the experiments of Mr. Marshall and Professor Plateau, and the observations of the late Mr. T. Belt, that certain species of spiders, together with Mantides and other predaceous insects, will be found to be among the chief, perhaps the chief, non-parasitic enemies of aposematic insects.

Colonel J. W. Yerbury has kindly searched his notes for any references to the attacks of spiders on butterflies. He writes, "I can find very few references to the relations of these two animals to each other in my old notes. The following are two of them:—

"'*Aden*, ? date.—A large green flower-haunting spider resting on a dried-up plant was preying on a female

*Teracolus vi.* The specimen was almost the first female of the species which I obtained. The individuals of this butterfly roosted regularly on the stalks of the plant in question, their under-sides being of about the same tint as the dried-up leaves and stems.

"'*Fatehpore Sikri, near Agra, May* 1877.—Spiders lay in wait for the Pierine *Belenois mesentina*, on the flowers of a caper (*Capparis aphylla*). On this occasion the spiders took a very heavy toll of the butterflies.'" *

[Mr. C. J. M. Gordon has sent to the Hope Department a male specimen of *Acræa bonasia*, which he found on January 8, 1902, at Old Calabar, in the grasp of a flower-haunting spider (*Thomisus*, sp.). The falces of the arachnid were fixed in the butterfly's thorax, and the insect was nearly dead.—E. B. P.]

### 6. The Attacks of Predaceous Insects other than Mantidæ upon conspicuous specially-defended Lepidoptera, etc. (E. B. P.)

H. W. Bates, in the historic paper which contained the first suggestion of the theory of Protective Mimicry (Trans. Linn. Soc., vol. xxiii, 1862, p. 495), states concerning the attacks of predaceous insects: "I never saw the flocks of slow-flying *Heliconidæ* [in the writings of Bates and Belt upon Mimicry, the *Heliconidæ* always include the *Ithomiinæ* or *Neotropinæ*, then called the *Danaoid Heliconidæ*] in the woods persecuted by birds or Dragon-flies, to which they would have been an easy prey; nor, when at rest on leaves, did they appear to be molested by Lizards or the predaceous Flies of the family *Asilidæ*, which were very often seen pouncing on Butterflies of other families" (p. 510).

There is, however, good reason for believing that such attacks are not rarely made, and that predaceous insects are important enemies of aposematic butterflies.

In the following three sub-sections of this paper I have brought together some slight evidence in support of this conclusion. Far more requires to be done, and it is hoped that the attention which is here directed to the inquiry

* Shortly after I had made the observation I came across a reference to this habit of the spiders at the very same place, but I cannot now recall the name of the publication.—J. W. Y.

may bring the subject to the notice of naturalists, especially in the parts of the world where the struggle for existence is keenest.

### A. *Predaceous Hymenoptera and Neuroptera.*

The Neuroptera are included here and not under a separate heading because I have as yet only received a single record, and that one in association with an observation on predaceous Hymenoptera. Accurate observations on Odonata and *Mantispidæ* are greatly needed, as well as on the predaceous Hemiptera. Large *Tenthredinidæ* should also be observed, for I have seen them devouring insects. *Locustidæ* furthermore are considerable and indiscriminate enemies of their class. I have seen them eating Acridians, and there is a specimen of one in the Hope Department together with its victim, a moth.

The late Thomas Belt long ago recorded the capture of Nicaraguan "*Heliconidæ*" by a yellow and black banded wasp for the purpose of storing its nest: "Whenever one of these came about, they would rise fluttering in the air, where they were safe, as I never saw the wasp attack them on the wing. It would hawk round the groups of shrubs, trying to pounce on one unawares; but their natural dread of this foe made it rather difficult to do so. When it did catch one, it would quietly bite off its wings, roll it up into a ball, and fly off with it" ("Naturalist in Nicaragua," Lond., 1888, p. 109). The following observation of Mr. Marshall's upon the chief unpalatable butterfly of the Old World compares in an interesting manner with the foregoing:—

"*Tugela River, junction with Blaauwkraantz River, Dec.* 14, 1896.—I have observed two enemies of *Limnas chrysippus* lately: one is a large wasp which I saw carrying off the larvæ, and the other was a very large red dragonfly which was devouring an imago." It is quite likely that the Odonata may not uncommonly attack such conspicuous butterflies, but this is the only record I have as yet received.

Experiments and observations on ants suggest an almost boundless field of inquiry. The following interesting observation made by my friend Mr. C. J. M. Gordon, M.A., of Balliol College, clearly proves that certain ants neglect

specimens of Acræas when they can get other butterflies. Mr. Gordon writes of two Acræas captured Jan. 13, 1902, at Old Calabar: "So distasteful do these butterflies seem to be that even the ants will not eat them. These specimens are the only survivors of a set of about twenty. The ants got in and ate all the rest, leaving these, as you see, untouched." It is interesting to note that the species were very different, being *Acræa admatha* and *A. neobule*. The specimens are in the Hope Department, Oxford.

### B. *Predaceous Coleoptera.*

A great deal of work remains to be done with the predaceous Coleoptera. So far as I am aware Professor F. Plateau is the only naturalist who has made any important use of them, but there is reason to infer from his experiments that they too are important enemies to aposematic insects. One section of his paper (Mém. de la Soc. Zool. de France, tome vii, p. 375, § 9) is devoted to experiments in which *Abraxas* larvæ were offered to *Carabus auratus*, *Dytiscus marginatus* [*marginalis*], and *D. dimidiatus*. Two of the *Carabi* in confinement were starved for about eleven hours, and then given one full-grown and two smaller larvæ of *Abraxas*. One beetle fed upon the large larva continuously for about an hour, only leaving the thoracic region. The other Carabus, of which one antenna was mutilated, after half-an-hour attacked one of the smaller caterpillars and then abandoned it. When the observer returned after a few hours both the smaller larvæ were partially eaten. Twelve hours later the beetles were perfectly well. The experiment was renewed with two fresh *Carabi* starved for eighteen hours. The beetles began to devour the larger of two larvæ given to them, and even fought over it: in an hour only the torn and empty skin remained. By the next morning the second larva had been devoured, and the beetles were quite healthy. Three imagines of *Abraxas* were then offered to two freshly-caught *Carabi*. After three hours one moth was nearly devoured, after about six hours the second, and by the following morning the third. There only remained some fragments of the wings. The beetles were as active as ever. Several larvæ were then thrown into an aquarium containing the two above-mentioned species of *Dytiscus*. The latter at once attacked them, fighting over their prey, which seemed to be entirely consumed.

These results are tolerably decisive; but it would have been more satisfactory if the experiments had been continued for a much longer period and controlled by others in which different forms of food were employed. In this way a convincing test of the wholesome qualities of the larvæ would have been supplied. In other experiments, again, it would have been desirable to offer a wide choice, and ascertain if there are any marked preferences.

Mr. G. A. K. Marshall has also observed one of the *Histeridæ*, *Hister caffer* (Erichs.), eating a far larger beetle than itself, the Scarabæid *Onitis alexis*. He has also observed the same beetle devouring *Aphodii*.

On July 19, 1898, I observed a large Elaterid (*Corymbites virens* ♀) eating the larvæ of *Vanessa urticæ* on a nettle beside the mountain road (6000 feet) from Leukerbad to the Gemmi Pass, Valais. The specimens are now in the Hope Department.

### C. *Predaceous Diptera.*

It is convenient to bring together the numerous records of the attacks of *Asilidæ* upon insects into a tabular statement. In its preparation I have received the kindest help and co-operation from Colonel Yerbury, Colonel Bingham, Mr. G. A. K. Marshall, Mr. A. H. Hamm, and Dr. Chapman.

* *Specimen in Hope Department, Oxford.* † *Specimen in Collection of British Museum (Natural History).*

| OBSERVER. | LOCALITY. | DATE. | SPECIES OF ASILID. | NAME OF PREY. |
|---|---|---|---|---|
| J. W. Yerbury. | Trinkomali, Foul Point. | Oct. 26, 1890. | *Maira*, sp.? ♀.† | Syrphid, Eumerus, sp.† |
| J. W. Yerbury. | Mahagany, Trinkomali. | Nov. 30, 1890. | ? Sp. and gen. ♀.† | Muscid.† |
| J. W. Yerbury (Zoologist, 1900, p. 539). | Trinkomali. | Nov. 1890. | *Microstylum apicale* (Wied.). | Cicadan, Tibicen nubifurca. |
| J. W. Yerbury. | Nilavelli, Trinkomali. | Nov. 16, 1890. | *Microstylum apicale* ♀.† | Acridian.† |
| J. W. Yerbury (Proc. Linn. Soc., v. 24, Zool., p. 551). | Trinkomali. | 1890—91. | *Promachus maculatus* (Fabr.). | Dragon-fly, Brachythemis contaminata (Fabr.).† |
| J. W. Yerbury. | Trinkomali. | July 18, 1891. | *Scleropogon ambryon* (Walk.) ♀.† | Dipteron, Scleropogon ambryon ♀.† |
| J. W. Yerbury. | Perivipancheram, Trinkomali. | April 21, 1891. | ? *Philodicus*, sp. ♀. | Dipteron, Large Tachinid, ? gen. and sp. |
| J. W. Yerbury. | Trinkomali. | June 25, 1891. | *Scleropogon ambryon* ♂.† | Butterfly, Tirumala limniace.† |
| J. W. Yerbury. | Periya Kulam, Trinkomali. | Oct. 18, 1891. | *Scleropogon ambryon* ♀.† | Another Asilid, ? gen. and sp.? |
| J. W. Yerbury. | Lyndhurst, New Forest. | May 27, 1894. | *Dioctria æland ica* (L.) ♀.† | Ichneumon.† |

* *Specimen in Hope Department, Oxford.* † *Specimen in Collection of British Museum (Natural History).*

| OBSERVER. | LOCALITY. | DATE. | SPECIES OF ASILID. | NAME OF PREY. |
|---|---|---|---|---|
| J. W. Yerbury. | Gravesend. | June 4, 1893. | *Dioctria atricapilla* (Mg.) ♀.† | Ichneumon.† |
| J. W. Yerbury. (Trans. Ent. Soc. Lond. 1899, p. 93). | Lahej, Aden. | March 6, 1895. | *Philodicus gracilis* (v.d.W.) ♂.* | Butterfly, Zizera gaika.* |
| J. W. Yerbury (Trans. Ent. Soc. Lond. 1899, p. 93). | Huswah, Aden. | April 14, 1895. | *Apoclea femoralis* (Wied.) ♀.* | Butterfly, Synchloe glauconome. |
| J. W. Yerbury. | Ledbury. | June 4, 1895. | *Dioctria rufipes* (Deg.) ♀.† | Ichneumon.† |
| J. W. Yerbury. | Lyndhurst. | June 25, 1894. | *Neoitamus cyanurus* (Loew) ♀.† | Coleopteron, ? gen. and sp.† |
| J. W. Yerbury. | Brockenhurst. | June 14, 1894. | *Machimus atricapillus* (Fallen) ♀.† | Dipteron, Chrysops cæcutiens (L).† |
| Guy A. K. Marshall. | Malvern, Natal. | March 28, 1897. | ? Gen. and sp. | Butterfly, Precis elgiva. |
| Guy A. K. Marshall. | Umtali, Mashonaland, 3700 ft. | Dec. 1900. | ? Gen. and sp. | Butterfly, Acræa caldarena (Hew.). |
| Guy A. K. Marshall. | Umtali, Mashonaland, 3700 ft. | Dec. 29, 1900. | *Alcimus*? *stenurus* (Loew) ♀.* | Butterfly, Lampides bœtica.* |
| Guy A. K. Marshall. | Salisbury, Mashonaland, 5000 ft. | May 5, 1901. | *Lophonotus*? *suillus* (Fabr.) ♂. 38·0 m.m. across wings.* | Dragon-fly, Trithemis arteriosa (Burm.). 47·0 m.m. across wings.* |

* *Specimen in Hope Department, Oxford.* † *Specimen in Collection of British Museum (Natural History).*

| OBSERVER. | LOCALITY. | DATE. | SPECIES OF ASILID. | NAME OF PREY. |
|---|---|---|---|---|
| Guy A. K. Marshall. | Salisbury, Mashonaland. 5000 ft. | Oct. 6, 1901. | *Promachus*, sp., perhaps *regalis* Wied. ♀.* | Dragonfly. Trithemis, sp., probably immature T. dorsalis (Ramb.).* |
| Guy A. K. Marshall. | Chirinda Forest, Gazaland, 4500 ft. | Dec. 12, 1901. | *Proagonistes*, sp., probably *præceps* (Walk.) ♀.* | Aculeate. Halictus, sp., close to torridus (Sm.), but smaller.* |
| Guy A. K. Marshall. | Salisbury, Mashonaland. | Jan. 26, 1902. | *Promachus æqualis* (Loew) ♀.* | Beetle. Heteromera, Lagria, sp.* |
| C. T. Bingham. | Domdami Valley, Martaban, U. Tenasserim. | Aug. 27, 1893. | *Promachus*, sp.? near *fasciatus* Macq. ♀. 35 m.m. across wings.† | Dragonfly. Rhyothemis plavilis (Selys). ♂. 78 m.m. across wings.† |
| C. T. Bingham. | Ataran Valley, L. Tenasserim. | April 1898. | *Damalina* ? sp. ♀.* | Aculeate, Melipona apicalis (Sm.).* |
| W. R. Ogilvie-Grant (Zoologist, 1900, p. 559). | Socotra. | | *Promachus solutrix* (Ric.) M.S. ♂.† | Small Cicada ? sp.† |
| E. B. Poulton. | Near Brieg, Valais, Switzerland, 2450 ft. | July 24, 1898. | *Dasypogon diadema* (Fabr.) ♂. | Dipteron, Sarcophaga, sp.* |
| E. B. Poulton. | Montserrat, near Barcelona. | July 15, 1901. | *Eutolmus ? apicalis* Loew ♂ ♀ in cop.: the lower insect, probably ♀, with prey.* | Dipteron; Anthomyid, Mydæa, sp., probably either urbana or pagana.* |

* *Specimen in Hope Department, Oxford.* † *Specimen in Collection of British Museum (Natural History).*

| OBSERVER. | LOCALITY. | DATE. | SPECIES OF ASILID. | NAME OF PREY. |
|---|---|---|---|---|
| E. B. Poulton. | Cerbère, Eastern Pyrenees. | July 17, 1901. | *Epitriptus arthriticus* (Zeller) ♀.* | Acridian, Podisma frigida (Boh.) ♂.* |
| E. B. Poulton. | Cerbère, Eastern Pyrenees. | July 17, 1901. | *Epitriptus arthriticus* (Zeller) ♀.* | Acridian, Podisma frigida (Boh.) ♂.* |
| G. C. Nurse. | Disa, Bombay Presidency. | June 1897. | *Neoitamus*, sp., perhaps *longistylus* (Wied.) ♀.* | "Beetle twice its weight." |
| G. C. Nurse. | Disa, Bombay Presidency. | Oct. 1899. | *Neoitamus*, sp., perhaps *griseus* (Wied.) ♀.* | Butterfly, Catochrysops contracta. |
| A. H. Hamm. | Port Bou, Eastern Pyrenees. | June 24, 1901. | *Dasypogon diadema* (Fabr.) ♀.* | Aculeate, Polistes gallica.* |
| J. C. Bowring. | Hong Kong. | Presented to B. M. 1861. | *Microstylum dux* (Wied.) ♀.† | Beetle, Protaetia mandarinea, "its beak through the elytra of the Cetonia." |
| T. B. Fry. | Probably Poona. | About 1888. | *Laxenecera* sp. ♀.* | Aculeate, Apis florea ☿ (Fabr.).* |
| T. A. Chapman (Ent. Record, 1902, p. 72). | Tragacete, Albarracin Mts., Spain. | July 18—26, 1901. | *Laphria gibbosa* (Linn.) ♂ and ♀ in cop.: the lower insect, the ♀, with prey.* | Beetle, Buprestis (Ancylocheira) flavomaculata, proboscis through cephalothoracic articulation.* A different beetle also seen transfixed by the same species. |

Colonel Bingham has sent me the following notes of his observations on *Asilidæ:* "With regard to flies of the family *Asilidæ* and spiders attacking butterflies, I find only a very few scattered notices of cases which I had seen, but no details, I am sorry to say. So far as I can remember I have seen these flies once or twice actually capture butterflies, and in one instance I find it noted in my diary that I found an *Asilus* with a *Junonia hierta* which was still slightly quivering its wings. I have seen the flies not once, but often swoop at butterflies, dragon-flies, and bees. I cannot, however, find any particular note of that case of the *Asilus* with a dragon-fly the specimens of which are in the British Museum. What note I made was written on the paper envelope in which the specimens had been put away. With regard to the *Asilus* which I found attacking the dammar bees (*Melipona*), I find that I have noted that they, the flies, persistently hover round the nest-mouth of the dammar bees, and catch the latter on the wing as they issue from the nest. The flies, so far as I have noticed, never eat their prey on the wing, but retire to a bush holding their prey with their long hairy legs."

A study of the table at once shows that the *Asilidæ* are most indiscriminate in their attacks. The stings of the Aculeates, the distasteful qualities of *Danainæ* and *Acræinæ* and of the odoriferous *Lagria*, the hard chitinous covering of Coleoptera, the aggressive powers of Odonata, are alike insufficient protection against these active and voracious flies. The only tendency towards specialization in the direction of any particular group of prey appears to be manifested in the preference of the slender Asilids of the genus *Dioctria* for Ichneumonids.* The far greater frequency with which the female Asilid has been observed with prey is sufficiently accounted for by the larger size of this sex and the more important part borne by it in reproduction.

Looking at the table as a whole, and the large proportion of attacks made upon specially-defended insects, the

* Since this sentence was written I have captured (July 1902) many specimens of *Dasypogon diadema* with prey at La Granja, Sierra Guadarrama, Spain. The great majority of these were sucking Aculeates, especially the hive-bee. Another species of Asilid, on Peñalara, also exhibited an apparent preference for Coleoptera.—E. B. P.

conclusion is suggested that Bates was mistaken in supposing that Asilid flies play no part as the enemies of *Heliconinæ* and *Ithomiinæ*.

7. Lepidoptera with Warning Colours specially liable to the attacks of Parasitic Insects. (G. A. K. M.)

[The late Erich Haase in his work on mimicry (English translation "Researches on Mimicry," etc., Pt. II, Stuttgart, 1896) continually made the assumption that the immunity of *Danainæ*, *Acræinæ*, and other specially-protected groups is absolute, and extends to the attacks of parasitic Hymenoptera and Diptera as well as to those of insect-eating vertebrates. A little reflection upon the rate of multiplication of animals, and especially of insects, makes it clear that any such absolute immunity is an impossibility. A high degree of protection from the attacks of the generality of insect-eating animals will always be found to be compensated by the attacks of special enemies, and probably very largely by that of insect parasites. I brought forward this argument in 1890 ("Colours of Animals," London, p. 181); and Haase, without attempting to meet it, made the crude assumptions which will now be dismissed, once and for all, by the numerous observations recorded below.—E. B. P.]

*Estcourt, Oct.* 15, 1896.—We brought seventy-five larvæ of *Acræa anacreon* home with us from Ulundi to Estcourt, and no less than twenty of them were killed by a Dipterous parasite, so that, although it may be protected in the imago stage, the percentage of larval deaths must be very high.

*Malvern, Feb.* 21, 1897.—I certainly cannot understand Haase's attitude with regard to protection from parasites. There are such patent examples to disprove it among European "whites." Out of eight pupæ of *Acræa horta* that I bred this season no less than five were killed by a Dipterous parasite.

[I have also received from Mr. Marshall two cocoons and two imagines of an ichneumon bred from *Acræa cabira* at Malvern. They bear the date April 1897.—E. B. P.]

*Umkomaas Mouth, Natal; Sept.* 3, 1897.—I think it is highly probable that *Byblia ilithyia* will prove to be distasteful as you suggest; but so far as my experience goes

the larvæ are very free from parasites, which in my opinion tells somewhat against that view.

*Salisbury, March* 6–10, 1898.—Of four larvæ of *L. chrysippus* I have taken this season two were killed by a parasitic fly [probably a *Tachina*] which attacks many different butterfly larvæ.

In his "Rhopalocera Malayana" (p. 407) Mr. Distant writes: "Mr. W. F. Kirby has kindly drawn my attention to the fact that several species of *Chalcis* have been reared from East Indian Danaids." *

[Colonel J. W. Yerbury at Aden "lost a great number of *chrysippus* larvæ from the attacks of a large dipterous parasite, one of the *Tachininæ*" (Journ. Bomb. Nat. Hist. Soc., 1892, p. 209).

Professor Félix Plateau, in his interesting paper on *Abraxas grossulariata*, L. (Mém. de la Soc. Zool. de France, tome vii, 1894, p. 375), also referred to on pp. 325–7, states that he found twenty-two caterpillars out of fifty-one, 43 per cent., attacked by insect parasites, viz. of Hymenoptera, two species of *Microgaster* and one of *Ichneumon;* of Diptera, the Tachinid *Exorista vulgaris* (Fallen). The caterpillar, *pace* Professor Plateau, is *most conspicuous*, and, as the Professor admits in the above-quoted paper, is refused by European insect-eating vertebrates with wonderful unanimity.

In the autumn of 1888 I found the conspicuous gregarious larvæ of *Pieris brassicæ* suffered to an enormous extent from the attacks of *Ichneumonidæ*. No less than 424 mature larvæ out of 631 died from this cause (Trans. Ent. Soc. Lond., 1892, p. 439). I have also observed an excessively high rate of mortality from the same cause among the conspicuous specially-defended larvæ of *Porthesia auriflua*. Dr. F. A. Dixey informs me that he has found the larvæ of *Euchelia jacobææ* much infested by ichneumons.—E. B. P.]

8. Experiments on Lizards and Frogs. (G. A. K. M.)

[Experiments with lizards and frogs were few and the results negative. A large number of the S. African species are no doubt specialized to eat only certain kinds of food, and these would be useless for experiment if their natural

* The names of *Chalcis cuplea*, Hope, and *C. albicrus*, Klug, are specially mentioned.

prey did not include members of the insect Order which it was desired to test. European lizards freely eat insects of all Orders, and have been found very satisfactory for such experiments. The African species which Mr. Marshall has actually seen hunting butterflies (see p. 435) should afford very valuable testimony as to the relative palatability of various Lepidopterous species and groups. Even if intolerant of captivity, they would probably thrive in an enclosure out of doors, with plenty of air, sun, and space. —E. B. P.]

*Estcourt, Oct.* 15, 1896.—I have just got a lizard to try experiments on with regard to the edibility of insects, but though it eats Diptera and some Orthoptera readily, it will not look at any of the butterflies I have given it, viz. *Terias brigitta*, *Pontia hellica*, and *Zeritis taikosama*. I had previously tried an Agama lizard with the same result, as I found that its natural food consisted almost entirely of ants.

*Malvern, Feb.* 21, 1897.—I have found *Pontia hellica* to be distasteful to a lizard.

*Salisbury, March* 6–10, 1898.—I kept a lizard for about a week, but it refused to eat any of the butterflies I gave it, but as it also refused termites the results were unreliable, and I let it go. In experiments of this kind the natural habits of the predatory animal must be taken into account, and the fact that a lizard prefers a fly to a butterfly may in some cases have no greater significance, so far as mimetic problems are concerned, than that a frugivorous bird prefers a berry to a butterfly.

*Salisbury, June* 5, 1898.—I have made several attempts at experiments with butterflies and lizards, but with no satisfactory results, as the latter seem to be unwilling to eat anything at all in captivity, remaining in a sort of listless condition.

*Malvern, May* 14, 1897.—Caught three frogs and put them in a box, and put in a wingless specimen of *Acræa natalica*. After a short interval the largest frog swallowed it. He made no sign to show that it was distasteful, nor did he disgorge it afterwards. For several days I put in specimens of various species, both edible and otherwise, but as none of the frogs paid the slightest attention to them I ceased to experiment.

9. Experiments on Captive Kestrels (*Cerchneis rupicoloides* and *C. naumanni*). (G. A. K. M.)

1899. *Salisbury, Mashonaland.*

January 2. Offered a young kestrel (*Cerchneis rupicoloides*) an *Acræa caldarena;* he took it in his beak, held it for a few seconds and then threw it away with a sharp shake of the head. Then gave him a *Byblia ilithyia*, which he accepted, but after making one or two pecks at it let it drop and would not touch it when it was again offered. I then tried him with an example of *A. nohara-halali* and *A. doubledayi-axina*, but he would have nothing to do with them.

„ 7. Gave the kestrel a large Buprestid beetle (*Psiloptera valens*, Pér. *i.l.*); he seized it in his beak with a cry of evident pleasure, then holding it in his foot tried to eat it, but after a peck or two it slipped from his grasp; I gave it back to him several times, but always with the same result—the beetle was too slippery. *Psilopteræ* are all eaten readily by baboons, and it would appear from this that their hard, shiny integuments combined with their torpedo-like shape form a very efficient protection (apart from their procryptic colouring) from all birds which are not sufficiently large to swallow them entire.

„ 8. Offered kestrel two *Blepisanis haroldi*, a small Longicorn with Lycoid markings, but he would not touch them; then a *Lycus rostratus*, at which he pecked but was evidently displeased with the taste, and neglected it.

„ 12. Gave kestrel a *Precis pelasgis*, *Junonia cebrene*, *Precis sesamus* ⊕ and *Atella phalantha*. He ate them all with evident relish, though he seemed to experience a little difficulty in managing them at first, as he could not get a good hold with his claw in order to pull them to pieces. So

the first two were practically swallowed whole, but the others were eaten piecemeal. I then offered a larva of *Limnas chrysippus*, which he accepted and held for some moments in his claw as though in doubt, but finally let it drop after a half-hearted peck. On re-presentation he would not touch it, so in order to restore confidence I gave him a grasshopper, on which insects he is usually fed. The species offered happened to have some rather light-green, yellow, and black markings; he took it with evident distrust and soon dropped it, although it was a species he had often eaten before. Thinking that the refusal was due to his experience with the brightly-marked larva of *L. chrysippus*, I offered some dully-coloured green and brown grasshoppers, which were readily eaten, and after them he also ate the one previously refused. I then offered a larva of *Acræa rahira;* he evinced a decided interest in it, but, although it crawled about over his feet, absolutely refused to touch it. This however may have been due to a generalized impression that all caterpillars were distasteful.

January 13. *Cercheis rupicoloides* ate one *Catopsilia florella.* A young bird of another species (*C. naumanni*) accepted a dead *Papilio demodocus;* for a few moments he seemed undecided where to attack it: then noticing the eye-spots in the hind-wing he promptly pecked them out, afterwards eating the rest.

„ 16. *C. naumanni* ate three *Terias brigitta;* both this species and *C. rupicoloides* refused the Lycoid *Prionocerus dimidiatus* with unmistakable signs of dislike.

„ 21. *C. naumanni* ate one *Precis pelasgis*, one *Axiocerces harpax*, one *Terias brigitta*, one *Catopsilia florella*, and one *Precis sesamus* (*natalensis* form) ⊕, all with

evident appreciation. *C. rupicoloides* appeared to have become tired of butterflies, refusing all, even those it ate before. Swynnerton found that it continually refused the brightly-coloured grasshopper mentioned above, but always ate it with relish when it had been dipped in meal to obscure its colours. *C. naumanni* on the other hand never refused the insect.

January 22. *C. naumanni* accepted a *Papilio corinneus*, but seemed in some doubt as to its edibility; he finally ate the thorax and threw away the abdomen. *Acræa halali* was then offered, tasted, and rejected. *Acræa anemosa* and *Limnas chrysippus* were likewise refused, and shortly afterwards one *Byblia ilithyia* and one *Terias brigitta* were eaten.

„ 23. *C. rupicoloides* escaped, and all the following notes refer only to *C. naumanni*. Kestrel ate one *Dichtha inflata* and one *Amblysterna vittipennis*. A *Lagria*, sp., was tasted and rejected.

„ 25. When very hungry the bird ate part of an *Acræa caldarena*, throwing away the rest. Subsequently he ate four *Belenois severina*, one *Junonia cebrene*, and one *Precis sesamus* (*natalensis* form).

„ 28. Two *Byblia ilithyia* eaten by kestrel. A *Clythra wahlbergi*, with strong Coccinellid odour, was eaten by the kestrel after some hesitation. Kestrel refused the Coccinellid *Epilachna dregei*.

„ 29. A Longicorn (*Ceroplesis fallax*, Pér.) offered to kestrel, which had been kept without food for some time. He was evidently nervous and much impressed by the stridulation of the insect. I therefore pulled the head off the beetle, and the hawk then ate it, but very slowly and in such a way as to lead me to suppose that it was not altogether palatable. Gave a *Piezia sclousi*, head first, to kestrel, which ate it readily though evidently noticing

the acidity of the abdomen. A *Polyhirma ænigma* was at once eaten by kestrel. I then offered him *Graphipterus lineolatus*, tail first; he pecked at it and received a small discharge of acid in the mouth, whereupon he shook his head and began wiping his beak vigorously on the perch, as though to get rid of the taste. Upon the beetle being presented head first, he took it with caution and ate it. The same results were obtained with *Graphipterus wahlbergi*, *G. bilineatus*, and *G. lineolatus*, they being refused when presented tail first and eaten when reversed. It should be noted that these beetles all discharge their secretions violently when captured, and therefore the kestrel would probably receive a comparatively small dose of the acid.

February 1. Gave kestrel an *Atella phalantha;* he seemed a good deal doubtful about it at first, but finally ate it without any signs of distaste. He then ate a *Junonia cebrene* and a *Byblia ilithyia* with manifest enjoyment. I then offered *L. chrysippus;* he accepted it readily, pulled off the head which he discarded, pecked a little at the tough thorax and wings, and then let it drop; on offering it again he took it, gave it a few pecks and jerked it away with his beak. He then ate a *Hamanumida dædalus* and accepted an *A. caldarena*, of which he ate a small part of the abdomen and threw away the rest. After this he ate with pleasure a *P. sesamus* (*natalensis* form), *J. cebrene*, and *B. ilithyia*. Several *Onitis alexis* were then given to the kestrel, which ate them readily. *Anomalipus plebeius* was too hard for him, and after five minutes' hard pecking he had only succeeded in pulling off the head; I therefore broke it up for him, and it was promptly eaten. He then refused *Clinteria infuscata*, *Mylabris holo-*

*sericea*, *Clerus* sp. (entirely scarlet, with strong verbena-like smell), and *Prionoccrus dimidiatus*.

February 3. Kestrel ate several dull-coloured *Curculionidæ* (*Oosomus*, sp., and *Eremnus*, spp.), refusing several *Onthophagus gazella* which were offered, also *Lycus ampliatus*, *L. rostratus*, and *L. constrictus*, all of which were tasted and were very evidently unpleasant.

„ 6. Kestrel refused *Zonitis*, sp., *Eletica rufa*, *Mylabris palliata*, and *Diacantha conifera*, after tasting each.

„ 15. The kestrel had been starved for twenty-four hours, and was very hungry. He ate the following insects, in the order given, with great avidity: two *Teracolus achine*, one *B. ilithyia*, two *Atella phalantha*, one *Junonia cebrene*, and one *Papilio corinneus*. I then gave him an *Acræa caldarena*, of which he first ate the head and swallowed the rest whole, one *A. rahira* was also swallowed whole; *L. chrysippus* was then offered; the bird ate the head, which seemed to raise suspicions in his mind, for he sat considering for some moments, and then began pecking at the thorax and wings and finally dropped it; on re-presentation he seized the butterfly, gave a few pecks at it, and jerked it away. Then one *Acræa axina* and two *A. halali* were swallowed whole, but *A. caldarena* which followed was only partially eaten, fully half being discarded. Another *L. chrysippus* was offered, and the entire head and thorax was eaten before it was thrown down. Later, the bird swallowed whole another *A. rahira* subsequent to eating several grasshoppers.

„ 28. Gave kestrel a *B. ilithyia*, which was eaten rapidly, and a second as well. He then ate a *Precis pelasgis* and another *ilithyia*, but an *Acræa halali* was pecked at once or twice and thrown away, and a fourth

*ilithyia* was treated in the same way, being apparently mistaken for an *Acræa*. I then offered a female *Anoplocnemis curvipes;* the bird ate the head, but evidently in some doubt; it continued with the thorax however, but showed its dislike by repeated sharp shaking of the head, and finally dropped the abdomen. I put a male of the same bug on its perch, but though it examined it carefully it would not touch it; yet this species is eaten greedily by the baboons.

[There are several very significant results from the above-recorded experiments on kestrels. The rejection of *Byblia*, after trial and rejection of an *Acræa*, may have been due to the superficial resemblance. On the other hand, this bird (*C. rupicoloides*) was apparently not fond of butterflies, for after eating (Jan. 12) *Precis*, *Junonia*, and *Atella* and (Jan. 13) *Catopsilia*, he refused all Rhopalocera. The refusal of an Acridian marked with bright green, yellow, and black, and its acceptance when the colours were hidden was almost certainly the result of unpleasant experiences with conspicuously-marked insects, of which a particular instance was afforded when the larva of *L. chrysippus* was offered. Such association of impressions brought about by very imperfect resemblances are of great importance in helping us to understand the origin of mimicry, both Batesian and Müllerian, in slight accidental resemblances of a very rough and imperfect kind. It also warns us not to regard as far-fetched or absurd those imperfect likenesses which may well be the early stages of incipient mimicry. The refusal of the Lycoid Longicorn *Blepisanis* may be similarly due to a previous experience of *Lycidæ*, or it may be truly distasteful and synaposematic. The latter interpretation is certainly true of the Lycoid Melyrid *Prionocerus* also refused by the kestrel "with unmistakable signs of dislike."

The other species of kestrel, *C. naumanni*, was much fonder of butterflies and of insects generally, eating the brightly-coloured grasshopper on all occasions. The fact that it took special notice of and pecked at the eye-spots on the hind-wing of *P. demodocus* is of much interest, and recalls an observation of my own quoted on pp. 440, 441. Such observations strongly confirm the interpretation of

eye-spots, especially upon the under-side of the wings, as directive marks leading an enemy to attack a non-vital part, and they tend to refute Portschinski's explanation of them as the representation in colour of drops of some specially-protective fluid (see p. 398).

Butterflies of different groups, *Hesperidæ*, *Pierinæ*, *Nymphalinæ*, were freely eaten, but the rejection of the abdomen of *Papilio carinneus* by the captive bird which afterwards ate *Byblia* and *Terias*, can only be explained on the supposition of unpalatability, and the same was evidently true in a more marked degree of Acræas and *L. chrysippus*, although parts of these would sometimes be eaten, while on Feb. 15, after starvation for twenty-four hours, many Acræas were swallowed whole. The behaviour on this occasion renders it certain that, as in the case of *Bucorax caffer*, *L. chrysippus* was far more distasteful to the kestrel than the Acræas.

The rejection, after trial, of the evil-smelling Coreid bug *A. curvipes*, greedily eaten by baboons, is a good example of the difference in value of the same defence with different enemies.

The treatment of Coleoptera almost invariably supported the theories which explain the meaning of insect colouring as cryptic, warning, etc.

The following beetles were eaten by the kestrel: *Curculionidæ*, with cryptic colouring (*Oosomus*, sp., and *Eremnus*, spp.); the large, slow-moving, conspicuous, black, earthy Heteromeron *Anomalipus plebeius*, when the chitin was broken; the smallish Buprestid *Amblysterna vittipennis* (dark metallic green or coppery with white stripe on each elytron); the Heteromeron *Dichtha inflata*, dark brown with reddish stripes, conspicuous and slow-moving like *Anomalipus*; the medium-sized Scarabeid *Onitis aleyis* with elytra and legs brown, and thorax iridescent green.

It is probable that most of the defensive fluid had been already discharged in the case of the *Carabidæ* of the genera *Pheia*, *Polyhirma*, and *Graphipterus*, of which the acid secretion was seen to be a very positive protection when there was opportunity for its operation on a normal scale. The Longicorn *Creoplesis fallax* with a Cantharid type of colouring may be synaposematic, as it was only eaten very slowly although the bird had been kept without food. The impression produced by the stridulation is of much interest (see p. 403).

The following beetles were refused, usually after tasting :—

Cantharidæ :—*Mylabris palliata*, *M. holosericea*, *Eletica rufa*, *Zonitis* sp. (all most conspicuous).

Coccinellidæ :—*Epilachna dregei* (characteristic colouring).

Cleridæ :—"*Clerus*" sp. (scarlet).

Phytophaga :—*Diacantha conifera* (Lycoid).

Melyridæ :—*Prionocerus dimidiatus* (Lycoid).

Lycidæ :—Three characteristically coloured species of *Lycus*.

Cetoniidæ :—*Clinteria infuscata* (orange thorax with two black spots, brown elytra, sometimes black).

Heteromera :—*Lagria*, sp. Probably distasteful, conspicuous and synaposematic with Phytophaga.

Scarabæidæ :—*Onthophagus gazella*, smallish Scarabæid with brown elytra and iridescent dark green thorax and head.

With the possible exception of the last named, all these species possess distinct aposematic colouring, and nearly all belong to groups which are much mimicked, or fall into important synaposematic combinations.

Mr. Marshall specially points out that the Kestrel, *C. naumanni*, was young, and it is probable that it had never before had experience of many of these species.—E. B. P.]

10. Experiments on a tame Ground Horn-bill (*Bucorax caffer*). (G. A. K. M.)

*Malvern, Natal, May* 14, 1897.

March 14. Gave a tame ground horn-bill (*Bucorax caffer*), belonging to Col. J. H. Bowker, the following butterflies: two male *A. serena*, one *P. lyæus*, one male *H. misippus*, one male *A. serena*, all of which he ate readily, taking them in the end of his beak, crushing the thorax and throwing them down his throat. I then gave him *L. chrysippus*. He took it, crushed the thorax and dropped it at once. A second specimen given a short time afterwards was treated in the same manner.

„ 24. Gave the following butterflies to ground horn-bill: three *A. encedon*, one *A. petræa*,

one *P. aganice*, two *J. clelia*, three male *H. misippus*, one *P. tropicalis*, two *P. brasidas*, two *P. demodocus*, one *P. lyæus*, and two *R. forestan*. He ate every one without the least hesitation, and evidently appreciated them, as he would follow me about, waiting for more.

April 1. Gave ground horn-bill one *A. petræa*, two *A. cabira*, one *P. brasidas*, one male *H. misippus*, and one *P. esebria*, all of which he ate readily.

[It has already been pointed out that the acceptance of insects by insectivorous animals in captivity is no proof of their normal likes or dislikes in a wild state. Such acceptance only proves what their action would be when they had been, from some exceptional cause, kept without their normal food in its usual quantity and variety. Hence the fact that the Acræas were devoured is no evidence that they are normally eaten except in a time of unusual hunger. On the other hand, the rejection of two *L. chrysippus*, after three Acræas had been readily eaten, indicates that the former butterfly is decidedly distasteful to this species of bird. It must be remembered that five Acræas were freely eaten on the next occasion. A comparison with the experiments on Mantides is interesting.—E. B. P.]

## 11. The Insect-food of wild South African Birds. (G. A. K. M.)

[Even more important than the results of experiments are the observations made and collected by Mr. Marshall upon the contents of the stomachs of birds, and the record of actual attacks made by birds upon insects, which have been witnessed in the field. The contents of birds are clearly shown in the two following tables, A and B, which are printed just as I received them from Mr. Marshall, except that I have added a brief description of the general appearance of those insects which seemed to require it. Mr. Marshall had only supplied such a description in three or four cases. In future records of this kind it will be advisable for the observer on the spot to supply such notes, together with a brief account of the habits, inasmuch as conspicuousness or concealment depend upon these quite as much as upon colour and pattern.—E. B. P.]

TABLE A.—*Contents of birds, probably* 1898, *unless otherwise stated, and Salisbury when no other locality is mentioned.*

| BIRDS. | INSECTS, ETC. | GENERAL APPEARANCE OF INSECTS. |
|---|---|---|
| *Macronyx capensis.* | COLEOPTERA, *Cleonus* sp., *Eremnus* sp., *Syagrus puncticollis*, Lefèv., *Sympiezíorrhynchus* sp. | *Syagrus*, a shining black, medium-sized Phytophagous beetle (*Eumolpidæ*). All others are weevils, and probably all with cryptic colouring. |
| *Irrisor erythrorrhynchus.* | HOMOPTERA, *Pyrops* sp. COLEOPTERA, *Platypria mashuna*, Pér., *Anthaxia* sp. | *Pyrops*, at rest are red-brown or greyish insects. *Platypria*, tawny with brown spots, very spinous (*Hispidæ*). *Anthaxia*, small green or coppery Buprestid. |
| *Coracias garrula.* | COLEOPTERA, *Gymnopleurus fastiditus*, Har. | Large, sooty-black, smooth Scarabeid. |
| *C. caudata.* | CRABS. COLEOPTERA, *Agrilus* sp., *Anthia pachyoma* (!). | *Agrilus*, small Buprestids, colour varies. *Anthia*, huge black Carabid with very powerful mandibles. |
| *C. spatulata.* | DIPTERA, fly-maggots from carrion. | |
| *C. olivaceiceps.* | ORTHOPTERA, *Phymateus morbillosus*, L. (a large evil-smelling bright-green locust with purple and crimson hind-wings). | Very conspicuous, with red thorax and head; legs red and yellow. |
| *Melittophagus pusillus.* | COLEOPTERA, *Onthophagus*, sp. | Genus of *Scarabæidæ*, varying much in size: metallic or black. |
| *Merops natalensis.* | COLEOPTERA, *Mylabris oculata*, Thunb. (!). | Characteristic Cantharid, aposematic, orange and black colours. |
| *Cuculus gularis.* | COLEOPTERA, *Nyassinius lugubris*, *Sphenoptera disjuncta*, *Hoplonyx* sp. | *Nyassinius*, small red-brown, rough Cetoniid, probably cryptic. *Sphenoptera*, dark metallic, coppery, moderate-sized Buprestid. *Hoplonyx*, medium-sized, black often polished, Heteromera (*Tenebrionidæ*). |
| *Asturinula monogrammica.* | ORTHOPTERA, *Clonia wahlbergi*. CENTIPEDES. | *Clonia* is a fine Locustid living among the leaves of trees. It is certainly procryptic. |
| *Falco subbuteo.* | COLEOPTERA, *Pentodon nireus*, Burm., *Onitis alexis*, *Anomala* sp. | *Pentodon*, large black Dynastid. *Onitis*, medium-sized Scarabeid, elytra and legs, brown; thorax iridescent green. *Anomala*, pale yellow brown, or metallic *Rutelidæ*; moderate-sized beetles. |

TABLE A.—(*continued.*)

| BIRDS. | INSECTS, ETC. | GENERAL APPEARANCE OF INSECTS. |
|---|---|---|
| *Cerchneis rupicoloides.* | CENTIPEDES. | |
| *C. naumanni.* | COLEOPTERA, *Heteronychus licas*, Klug., CENTIPEDES. ARACHNIDS, *Solpuga marshalli*, Poc. | *Heteronychus*, smallish black, rather shining Dynastid. *Solpuga* is red-brown, distal part of 4th leg black, broad median black band on abdomen which is clothed at sides with yellowish-white hairs. It runs very swiftly and its habits are strongly procryptic. |
| *C. amurensis.* | COLEOPTERA, *Hydaticus*, sp. | Moderate-sized, oval, polished dark-brown *Dytiscidæ*. |
| *Bubo maculosus.* | COLEOPTERA, *Hesperophanus amicus*, white. | A large red-brown Cerambycid: procryptic. |
| *Herodias lucidus.* | Dragon-flies and aquatic Hemiptera. | |
| *Ciconia abdimii.* | COLEOPTERA, *Psammodes ventricosus*, Fähr., *P. scabratus*, Gerst., *Polyhirma semisuturata*, Chd., *Piezia marshalli*, Pér., *Scarites*, sp. HYMENOPTERA, Ants of the genus *Carebara*. | *Psammodes*, both species are large dull-brown Tenebrionid Heteromera. *Polyhirma*, moderate-sized, black Carabid with white markings. *Piezia*, a Carabid superficially similar to last. *Scarites*, shining black Carabids of variable size; large mandibles. |
| *Numida coronata.* Shot by C. F. M. Swynnerton at Mazoe, Mashonaland, 4000 ft. | COLEOPTERA, 2 *Psiloptera chalcophoroides*, Pér., 1 *Hipporhinus bohemanii*, Fähr., 1 *Phantasis gigantea*, Guèr., 1 *Macrocoma aureovillosa*, Mash. These five specimens were taken from the crop, December 25, 1898, by Guy A. K. Marshall. They are now in the Hope Collection, Oxford, and are extraordinarily perfect, retaining the legs and in some cases the antennæ. | *Psiloptera*, largish iridescent bright-green Buprestids. *Macrocoma*, a small golden-green iridescent Phytophagous beetle. *Hipporhinus*, a large brown rough cryptic weevil. *Phantasis*, a large Longicorn generally similar to the above, and probably mimetic of certain very hard *Curculionidæ*. |
| *Merops natalensis*, September 1901. | LEPIDOPTERA HETEROCERA, the Saturniidæ *Pseudaphelia apollinaris* and *Cirina similis*. | The moths both conspicuous, slow, day-flying, and probably distasteful species. *Pseudaphelia*, is large semi-transparent, whitish with black markings; *Cirina* is still larger and dull pink. |

TABLE B.—*Insects, etc., in stomachs of birds (probably 1898), Salisbury.*

| COLEOPTERA. | BIRDS. |
|---|---|
| *Polycleis decorus* (largish weevil, varying much in colour, but always with more or less of a pattern). | *Oriolus notatus, Coracias caudata, Halcyon pallidiventris.* |
| *Trochalus* sp. (small rounded often polished black-brown or greenish Lamellicorns; probably mimics of *Galerucidæ, Chrysomelidæ,* and *Coccinellidæ*). | *Bradyornis mariquensis, Fringillaria tahapisi.* |
| *Cassida* (*Aspidomorpha*) *punctata,* F. (medium size, abundantly black-spotted, colour probably reddish-brown when fresh). | *B. mariquensis, Irrisor erythrorrhynchus, Campothera bennetti.* |
| *Alcides hæmopterus,* Boh. (smallish weevil with red-brown white-spotted elytra and black thorax and head). | *Prionops talacoma.* |
| *Oosomus* sp. (an entirely black, arboreal or subcortical weevil). | *Graucalus pectoralis, Upupa africana, Irrisor erythrorrhynchus, Campothera bennetti.* |
| *Zophosis* sp. (black quick-running Heteromeran). | *Geocichla litsitsirupa.* |
| *Onthophagus gazella* (smallish Scarabæid with brown elytra and iridescent dark-green thorax and head). | *Caprimulgus rufigena, Falco subbuteo* (in large numbers). |
| OTHER INSECTS, ETC. | |
| Pentatomid bugs. | *Geocichla litsitsirupa, Laniarius guttatus, Irrisor erythrorrhynchus, Cerchneis amurensis, Coccystes glandarius.* |
| Reduviid bugs. | *Macronyx capensis, Rhinopomastus cyanomelas.* |
| Ant-lion larvæ. | *Thamnolæa cinnamomeiventris.* |
| Ants. | *Bradyornis mariquensis, Pratincola torquata, Monticola angolensis, Saxicola pileata, Buchanga assimilis, Thamnolæa cinnamomeiventris, Crateropus kirkii, Lophoceros leucomelas, Campothera bennetti, Crecopsis egregia.* |

TABLE B.—(*continued.*)

| OTHER INSECTS, ETC. | BIRDS. |
|---|---|
| Other Hymenoptera. | *Rhinopomastus cyanomelas*, and all four species of bee-eaters. |
| Hairy caterpillars. | *Oriolus larvatus*, and all the cuckoos. |
| Millepedes. | *Turdus libonyanus.* |
| Scorpions. | *Coracias olivacciceps, Cerchneis rupicoloides, Asturinula monogrammica* (apparently favourite food with this species). |
| VERTEBRATES. | |
| Lizards. | *Melierax polyzonus, Astur polyzonoides, Aquila wahlbergi, Circætus pectoralis, Cerchneis rupicoloides*, and *Glaucidium perlatum.* |
| Snakes. | *Astur polyzonoides, Buteo jakal, Circætus pectoralis, Bubo maculosus.* |

## RESULTS OF TABLES A AND B.

[The almost complete absence of the members of aposematic Coleopterous groups is very marked. In fact, the whole of the numerous beetles are probably cryptic, with the following exceptions. The species of the Eumolpid genus *Syagrus* is probably distasteful; for it freely exposes itself on leaves, where its shining black appearance renders it conspicuous. It is worthy of note that the only bird in which it was found, *Macronyx capensis*, also ate Reduviid bugs. The Phytophagous *Macrocoma aureovillosa* belongs to a probably distasteful group, but it is itself green in colour; it was only eaten by one species. The Hispid *Platypria* is probably distasteful, and here too the only species of bird which ate it, *Irrisor erythrorrhynchus*, also ate the conspicuous *Cassida* (*Aspidomorpha*) *punctata* and Pentatomid bugs. The above-named Cassid was also found in two other species of bird. The most remarkable exception is however the typically-coloured Cantharid, *Mylabris oculata*, only detected in *Merops natalensis*. Here we find the interesting proof that under certain circumstances, and with certain enemies, the most marked distasteful

or unwholesome qualities accompanied by the most conspicuous orange and black aposematic coloration may afford no protection. Furthermore, it is of great interest to observe that the same species of bird was the only one in which two conspicuous and almost certainly distasteful Saturniid moths were found. The *Carabidæ* of the genera *Anthia*, *Polyhirma*, *Pizia*, and *Scarites* are not so remarkable. *Scarites* is probably nocturnal and entirely procryptic, while the defensive secretions of the three other genera may be discharged and lost as the result of the attacks of an experienced enemy.

Outside the Coleoptera, the number of birds which ate Pentatomid bugs is remarkable (five species), and it would be interesting if it were possible to obtain the remains and make out the species of these Hemiptera. The specialization of enemies to feed upon forms which have become excessively abundant through specialization in their modes of defence is seen in the two species which contained ants, and the three which had eaten scorpions. The hairy caterpillars eaten by cuckoos are a similar case; this group of birds being specialized to feed on insects which are specially defended against the majority of insect-eaters. The fact that *Phymateus morbillosus*, a large, conspicuous, and strong-smelling locust, had been eaten, is also of interest. *Solpuga marshalli*, in spite of its formidable appearance, is quite harmless, with procryptic appearance and habits. The Tables as a whole afford wonderfully strong support to the existing theories which explain cryptic colouring and instinct as the defence of forms which are eagerly sought for as food by numerous enemies, and an aposematic appearance and mode of life as the defence of specially-protected forms only attacked under the stress of hunger or by comparatively few specially-adapted foes.—E. B. P.]

## 12. Records of Attacks on Lepidoptera, especially Butterflies, by wild South African Birds. (G. A. K. M.)

[The stimulus which induced Mr. Marshall to collect observations on the attacks of birds upon butterflies was provided chiefly by the account of the discussion which followed Dr. F. A. Dixey's paper on "Mimetic Attraction" (Trans. Ent. Soc. London, 1897, p. 317; Discussion in

Proc. 1897, pp. xx–xxxii, xxxiv–xlvii). The following extracts from a letter indicate the line Mr. Marshall would have taken had he been in England at the time.—E. B. P.]

*Malvern, Natal; Oct.* 7, 1897.—I am much struck with the large amount of adverse criticism levelled against the theory of even Batesian mimicry. The theory of convergence (Müllerian mimicry) might perhaps be considered as debatable, but how any one who has paid any attention to the subject can doubt the reality of Batesian mimicry, I cannot understand, and the attempt to explain it away by climatic causes seems to me weak in the extreme. If the view, advocated by many, that birds cannot be reckoned among the principal enemies of butterflies in their imago state, be true, then I consider that we may practically abandon the whole theory of mimicry as at present applied to the *Acræinæ* and *Danainæ* of South Africa at all events, for from what I have observed of these insects I am convinced that their warning coloration cannot have reference to either mantises, *Asilidæ*, or lizards, which are practically the only other enemies that can be taken into account. Moreover, the swift flight of the majority of edible species can only have been developed to enable them to escape from *winged* enemies, and that this development is due to *Asilidæ* or dragon-flies is more than I can believe. Certainly the paucity of records of birds eating butterflies is somewhat disconcerting, but this is doubtless due to the fact that not sufficient attention has been paid to the subject, which would entail long and patient observation of the birds themselves, an occupation that the average entomologist is not likely to indulge in when out collecting. Personally I do not suppose I have seen such an occurrence more than perhaps half-a-dozen times; the birds being the Paradise flycatcher (*Terpsiphone perspicillata*), the bee-eater (*Merops apiaster*), and two rollers (*Coracias spatulata* and *Eurystomus afer*); but then I admit that I have paid little or no attention to the matter until quite recently.

The habits of the *Teracoli*, especially in their winter forms, have always seemed to me strongly suggestive of their being frequently attacked by birds. With hardly an exception they are fairly swift fliers (especially the "purple-tips"), keeping comparatively close to the ground and dodging well. If struck at gently as they fly by, they dodge and hurry onwards but still continue their

flight; if however they be thoroughly frightened by continued strokes of the net, they will dart rapidly on for a short distance, then vanish—or, in other words, they settle with extreme suddenness, and their under-side colouring harmonizes so well with the sandy soil they love that they are very difficult to detect. It seems to me that such a habit can only have been developed for the purpose of escaping from birds, and must be very effectual in most cases. I have noticed that the summer forms, which have not the sandy-coloured under-side do not adopt these tactics, but rely on their flight alone—probably because food is more plentiful for insectivorous birds at that season.

[After this, Mr. Marshall kept a careful record of observations. His results, including one observation made at an earlier date, are shown on pp. 357–9 in the form of a diary. The two following letters bear on the same subject.—E. B. P.]

*Salisbury, March* 6, 1898.—I was much interested in your arguments * for Common Warning Colours in butterflies and your remarks on their probable enemies, but I must candidly confess that I am not altogether convinced. The difference in our views lies in your fundamental proposition that butterflies are an easy prey for birds to capture from a general point of view. If this proposition be correct, then I quite agree that your theory offers the most natural and probable explanation of the predominance of bright colours among butterflies. But from what I have seen of the South African species I could not truthfully say that I consider that they would be likely to fall an easy prey to birds, indeed I should say that the average insectivorous bird would not have a chance against most of the swift-flying species when on the wing, and would only be able to catch them under exceptionally favourable circumstances when the insects were off their guard. If this supposition be correct it would go a good way to explain how so many butterflies have been able to acquire such brilliant colours, and particularly in the case of those species which have protectively-coloured under-sides, which is the rule rather than the exception. Birds would soon learn the futility of attempting to *pursue* such species, and would only capture them by stealth, and in a more or less

* Some of the arguments here referred to are set forth on pages 500 to 502 of the present memoir.—E. B. P.

unobtrusive manner, which might account for the paucity of records. The fact that birds have been seen to capture moths more frequently than butterflies need not necessarily imply a preference for the former insects, but might be explained on the supposition that they are aware that they can be captured more or less easily on the wing, and therefore that when a moth does happen to get well up into the air in open country it is promptly pursued, whereas under similar conditions a butterfly would be allowed to pass unmolested. While on the subject of swift flight I might mention that I was much struck during my visit home with the *slow* flight of English butterflies as compared with the generality of South African species. I am inclined to agree with Trimen in his Presidential Address to the Entomological Society, that birds are among the chief enemies of butterflies. That they have been the chief, if not the only, agents in the production of mimicry, whether Batesian or Müllerian, I have little doubt. It is highly significant that mimicry in its fullest development is only to be found in forest-clad regions where insectivorous birds are most abundant. Moreover, I am not aware of a single instance of true mimicry among species which *habitually* settle on the ground.

*Salisbury, March* 10, 1898.—It would seem that mere unpleasantness of taste or smell would hardly be sufficient to give so great an immunity from attack from birds as is apparently enjoyed by the *Danainæ* and *Acræinæ*, unless accompanied by poisonous or unwholesome qualities—at least, if we may judge by other orders of insects. A large number of Rhynchota, for instance, possess a very unpleasant smell, and yet their colouring is procryptic instead of aposematic. In the crop of the great spotted cuckoo I have found a large green Pentatomid, which in the strength and unpleasantness of its smell is only beaten by *Petascelis remipes*, our largest Hemipteron. Again, in the crop of the racquet-tailed roller (*Coracias caudata*, Trim.) I have found a full-grown specimen of a large *Phymateus* locust, which is a most evil-smelling beast. This insect appears to combine procryptic and aposematic colours; for when settled its general green colour is eminently protective, but during its laboured flight it is most conspicuous owing to its brilliant crimson and purple hind-wings. If annoyed when settled on the ground they often raise their wings over their backs (clearly to exhibit

the bright colours), exuding at the same time an odoriferous frothy liquid from the thorax.

1897.

March 28. While out collecting at Malvern, Durban, Natal, I saw a Paradise flycatcher (*Terpsiphone perspicillata*) catch a specimen of *Eronia cleodora*. The butterfly was hovering over a flower when the bird swooped down, seized it *with its feet*, and carried it off.

1898.

Feb. 27. Saw a Marico wood-shrike (*Bradyornis mariquensis*) dart down from a tree and catch a *Sarangesa eliminata* (Holl.), which was sitting with outspread wings on a small plant.

March 6. Saw a flycatcher (*Pachyprora molitor*) make several futile attempts to catch a *Tarucus plinius* which was circling round the bush on which it sat.

Nov. 23. Saw a bush kingfisher (*Halcyon chelicutensis*) catch and eat two butterflies, viz. *Junonia cebrene* and *Catopsilia florella*, both of which were captured when feeding.

Dec. 1. C. F. M. Swynnerton saw a drongo (*Buchanga assimilis*) fly past him with a white butterfly in its beak, probably *C. florella*.

„ 15. Remains of *Papilio demodocus* found in the stomach of a cuckoo (*Coccystes caffer*).

1899.

Jan. 1. While watching an *Atella phalantha* hovering over a bush of its food-plant, a Paradise flycatcher (*Terpsiphone perspicillata*) darted past, and with a loud snap of its beak tried to catch the butterfly in its swoop. The latter escaped, however, and on following it up I found that the tip of one hind-wing had been cut clean off; unfortunately I had no net and failed to capture the insect.

Swynnerton shot a hobby (*Falco subbuteo*), which had in its stomach an almost

complete *Terias*. The thorax and abdomen were quite uninjured, but the tips of the fore-wings were gone.

April 26. I was watching a drongo hawking insects from the top of a dead tree; there were many *Pierinæ* about, chiefly *Teracolus* and *Belenois*, but the bird paid not the least attention to them. At last a *Belenois* came by which had its wings very much shattered, so that its flight was weak and erratic; the drongo observed it at once, and swooped down on it, but I saw the butterfly drop into the long grass. Whether it was injured by the bird I could not say, as I was unable to find it, and I did not see it rise again. This episode would point to the conclusion that the fact that birds refrain from pursuing butterflies may be due rather to the difficulty in catching them, than to any widespread distastefulness on the part of these insects.

1900.

C. F. M. Swynnerton wrote from Gazaland: "In March [1900] I saw a *Pratincola torquata* [South African stonechat] in chase of *Tarucus plinius*. Had it not been frightened off by coming face to face with me, it would undoubtedly have caught it. I think I told you long ago of having found the wings of a lot of butterflies, chiefly *P. corinneus*, below the branch of a tree on which some swallows were constantly settling."

May 13. Salisbury. Saw a drongo (*Buchanga assimilis*) swoop from a tree and catch, what I took to be an injured *Belenois*, which it dropped almost at once. I marked the insect down, and found it to be a common white moth of the distasteful genus *Diacrisia* (*D. maculosa*).

1901.

Dec. 17. Melsetter, 5500 feet, Gazaland. A specimen of the large, conspicuous, Hypsid

moth *Callioratis bellatrix* was seized and rejected by a drongo, undoubtedly a young bird, judging by its plumage. [The moth, which is now in the Hope Department, has lost most of the head, but is otherwise uninjured.—E. B. P.]

13. Records of Attacks on Butterflies by wild Birds in India and Ceylon, by Colonel J. W Yerbury, R.A.

[Colonel Yerbury has kindly extracted from his notes all the observations he has made bearing on this interesting question.—E. B. P.]

"About the year 1884 a discussion arose in the Bombay papers as to whether birds preyed on butterflies, and the general opinion expressed was that it was comparatively rare for them to do so. In common with some other members of the Bombay Natural History Society, I determined to watch and note the results. My records taken from old diaries are as follows:—

1884.

Neighbourhood of Poona and Aden. None.

1885.

Sept. 23. Aden, Campbellpore, and Murree Hills. Road up Thundiani, near the Kala Pani Bungalow. Saw a young king-crow, *Dicrurus ater*, stoop at a big blue *Papilio*, either *P. polyctor* or *P. arcturus*, and miss it. The bird did not repeat the attempt.

1886.

Sept. 2. Campbellpore, Thundiani, etc. Road up Thundiani, near top of the hill. Saw a young king-crow stoop at a specimen of *Vanessa kaschmirensis*, and after missing it once take it at the second attempt. Did not notice whether the insect was eaten.

1887.

Rawul Pindi and home, *viâ* Japan and America. None.

1888–9.

At home.

1890.

June. Ceylon, Trinkomali. No record.

1891.

Nov. 14. On the Kandy Road between Trinkomali and Kanthalai; butterflies in great numbers sitting on the wet mud by the roadside; chiefly *Pierinæ* (*Catophaga*), but a few *P. nomius* with them. These butterflies rose in clouds as one drove past. A bee-eater, *Merops philippinus*, kept flying in front of my carriage and taking specimens of these butterflies as they rose. The bird seemed to select the yellow females, which are rare, the white females being to them probably in the proportion of 100 to 1. These flocks of butterflies often unite and form what are known as snowstorms in Ceylon; they then migrate right across the island.

"These bee-eaters were often seen catching *Pierinæ;* in fact, it seems to have occurred so often that I ceased to record the fact, for I can only find this one reference. Probably the attacks were always witnessed at the beginning of the N.E. monsoons during the time of the heavy rains, *i. e.* September to December.

"I am not certain as to the date on which I saw the Ashy swallow-shrike (*Artamus fuscus*) catching specimens of the Euplœa *Crastia core*. The fact is associated in my mind with a particular place, and with the capture of *Charaxes psaphon* ♀ there. This is recorded for April 12th, 1891, so this may be the correct date on which I watched the bird. At least six specimens of the *Crastia* were captured by the shrike, all of which it carried away to a branch high up in a big tree, but I could not see whether they were eaten.

"As regards my experience of birds catching butterflies, it appears to have occurred more frequently in damp than in dry districts; *e. g.* it was frequent in Ceylon, rare in

places with moderate or small rainfall, such as Campbellpore, Poona, and Aden.

"In my opinion an all-sufficient reason for the rarity of the occurrence exists in the fact that in butterflies the edible matter is a minimum, while the inedible wings, etc., are a maximum."

[See Proc. Zool. Soc. 1887, p. 210, where Lepidoptera and especially butterflies are spoken of in almost exactly these terms, as a suggested explanation of the fact that lizards, although they eat them, greatly prefer flies or cryptic larvæ.—E. B. P.]

14. Records of Attacks on Butterflies, etc., by wild Burmese Birds, by Colonel C. T. Bingham.

[Colonel Bingham has kindly sent me the following extracts from his 1878 diaries, for incorporation in the present memoir.—E. B. P.]

"*April* 23.—Marched from Kawkaraik to Thinganyinaung, fourteen miles. Started about 7.45, rather late as there was some difficulty in collecting the elephants this morning. . . . The road, a mere jungle path, followed the course of the Akya Chaung, a feeder of the Haundraw River, and crossed the little stream some twenty or more times in the first six or seven miles before turning up the hill to the Taungyah Pass in the Dawnat Range. From the outskirts of Kawkaraik right up to Thinganyinaung on the other side of the pass, the road goes through dense evergreen forest, and consequently the collecting is very good on this road, both for insects and birds. To-day, the day being hot, butterflies, bees, and dragon-flies swarmed, and at every opening of the Chaung I found crowds seated on the damp sand apparently sucking up the moisture. Collecting as I went, it was past 11 o'clock before I got to the foot of the Pass. I was hot and a bit tired, so I sat down on a fallen tree to rest, just before crossing the Akya Chaung for the last time. I had not been seated many minutes looking at the swarms of butterflies, bees, and dragon-flies, which were flitting about or sitting on the sands, when my attention was attracted by a bird, a bee-eater (*Merops swinhoei*), which swooping down from a tree overhead caught a butterfly, a *Cyrestis*, within a few paces of me. The bee-eater seemed to catch the butterfly with ease, and I distinctly heard the snap of its bill. Then holding the butterfly crossways the bird flew back to the

tree, and sat still for a minute or so, then came a little jerk of the head, and the wings of the butterfly came fluttering to the ground, while the body was gulped. On the same branch some four or five more bee-eaters of the same species were seated, and as I sat very still, one after another these birds swooped close to me, sometimes after a butterfly, sometimes at a bee or a dragon-fly. More than once I saw a bird miss a butterfly, when the latter would dodge and try to get away among the bushes of the dense undergrowth around, but only very seldom was this successful, for the bird would hover and twist and turn in hot pursuit, and generally managed to catch the insect. I was greatly interested, for though I had seen both bee-eaters and king-crows (*Dicrurus*) go for butterflies and moths, this was the first time I had witnessed a continuous hawking of butterflies on the part of birds. I sat for nearly half-an-hour watching. The birds seemed to swoop only for the insects flying about, never at those on the ground. A drove of pack bullocks with their shouting Shan drivers coming down the road frightened the bee-eaters, and they flew off. I got up and prepared to start up-hill, when it struck me that it would be interesting to see what species of butterfly had been taken by the bee-eaters, so I set to work and collected all the loose wings I could find. I did not get many, for the undergrowth was very dense, and the wings dropped in it were difficult to find. Also the place swarmed with ants, I could see them on all sides carrying off whole wings, or portions bitten out of them. Again I was pressed for time, so that I managed to get together only nineteen wings, most of them odd ones luckily. . . . I have just sorted out and put away my collections of the day. The butterflies hawked and eaten by the bee-eaters belong to the following species—*Papilio crithonius, P. sarpedon, Charaxes athamas, Cyrestis thyodamus,* and *Terias hecabe.* A meagre list, for I am certain I saw the bee-eaters swoop for and catch *Prioneris, Hebomoia, Junonia,* and *Precis.* I also particularly noticed that the birds never went for a *Danais* or *Euplœa,* or for *Papilio macareus,* and *P. xenocles,* which are mimics of *Danais,* though two or three species of *Danais,* four or five of *Euplœa,* and the two above-mentioned mimicking *Papilios* simply swarmed along the whole road." *

* I did not then realize the importance of my find, or I should have spared more time for the collection of the fallen wings of the butterflies, and taken more care of them.—C. T. B.

Looking through my diaries I find more scattered notes of my having witnessed birds swoop for and catch butterflies and moths, but these were solitary incidents, and only slight mention is made of them in the diaries with one exception, which is given below—

"*Camp Wabosakhan,* December 3. . . . Going through some fairly open jungle close to the main road I put up a *Melanitis zitenius,* which fluttered across the road and was swooped at by a king-crow (*Dicrurus*) but missed; the butterfly dodged, got to the other side of the road and dropped to the ground among the herbage and fallen leaves, as is the habit of *Melanitis.* The king-crow hovered for a minute not three feet from the ground over the exact spot where I had noticed the butterfly drop, failed to see it, flew off, but returned and again hovered over the spot, but was again unsuccessful, and flew up to a tree. I went forward very cautiously, and having carefully noted the spot where the butterfly had dropped, was enabled to make it out, but not till after fully ten minutes of patient and very cautious looking. The *Melanitis* was there among dead leaves, its wings folded and looking for all the world a dead dry leaf itself. With regard to *Melanitis,* I have not seen it recorded anywhere that the species of this genus when disturbed fly a little way, drop suddenly into the undergrowth with closed wings and invariably lie a little askew and slanting, which still more increases their likeness to a dead leaf casually fallen to the ground.

"Only once again did I see the systematic hawking of butterflies by birds. This second occurrence was also by bee-eaters; this time it was the large *Merops philippinus.* I had been up in the Salween forests beyond the great rapids, and had managed to get a bad bout of fever which necessitated my returning to Moulmein, my head-quarters. It was a hot steamy day in October, and I was lying with the hot fever fit on me in the boat on the Salween below Shwègon, when I noticed clouds of butterflies, chiefly *Catopsilia,* migrating, crossing the Salween from east to west in a continuous stream. These were being persistently hawked by the *Merops,* mixed with which were some king-crows."

With regard to *Microhierax caerulescens* catching butterflies, I find the following note :—

"*March* 20, 1881. . . . Passing through a taungyah on my way back to camp I noticed a number of butterflies,

some seated, some hovering round a spot where some Karens had been eating their food, and had left some rice and gnapi scattered on the ground. I was approaching the butterflies cautiously to see what species were there, when a small black-and-white bird came down from a tree close by and perched on the ground close to one little mob of butterflies busy feeding away on the gnapi. I recognized the bird at once as the pigmy hawk (*Microhierax caerulescens*). His coming flop down close to the butterflies disturbed some, but not all. A few were too intent on their meal. The hawk sat for fully two minutes looking at the butterflies, then he crouched as birds do when they are about to rise, and next moment with a quick snatch he had taken a butterfly in his claws and was flying to the nearest tree. Though I was watching intently I am quite unable to say whether he took one of the sitting butterflies or one that was flying about. I watched him eat the insect, which he held with his claw against the branch on which he was seated, and he tore at it just as the larger hawks do with their prey. I wanted a specimen of the bird, so shot it, and afterwards picked up the wings of the butterfly he had eaten; it was a *Papilio sarpedon*."

N.B.—That same specimen of *Microhierax* is now, I believe, in a small case by itself in the bird gallery of the British Museum.

[Colonel C. T. Bingham has also made some interesting observations on the use of insects' wings as a pad at the bottom of a hole in a tree, forming the nest of this same species of bird, the falconet *Microhierax cærulescens*, Linn. (*M. cutolmus*, Hodgs.). The following account is quoted from "Stray Feathers" (vol. v, No. 2, June 1877, pp. 79–81). The observations were made in the "Government Teak Reserve on the Sinzaway Chaung, a feeder of the Yoonzaleen River, which it enters about two days' march below our frontier station of Pahpoon in Tenasserim." The nest was found on April 14, "in a hole on the underside of a decayed bough of a mighty Pymma tree (*Lagerstræmia Flos Reginæ*)." The four eggs were found to be "stained by resting on the broken leaves, wings of dragonflies, and bits of wood which composed the nest." The editor appends to this account a note of Davidson's which had been in his possession for years. On March 25 the nest of *Microhierax fringillarius*, Drap., was examined. It had been made in a hole in a dry tree in an old taungyah (clearing) "near Bankasoon at the extreme south of Tenas-

serim." "At the bottom of the hole, which was about eighteen inches deep, was a soft pad composed of flies and butterflies' wings, mixed with small pieces of rotten wood."

In March 1878, Col. Bingham found a second nest of the same species (*M. cærulescens*) which he sent to the late Mr. de Nicéville in order to ascertain the species of insects which had been made use of. Mr. de Nicéville wrote as follows:—

"The fragments of butterfly wings you send are as follows:—

No. 1. Portion of fore-wing of *Papilio caunus*.
„ 2. Fore- and hind-wing of *Mycalesis perseus*.
„ 3. Hind-wing of *Papilio erithonius*.
„ 5. Portion of fore-wing of *Junonia orithyia*.
„ 4, 6, 7, 8, 9, too fragmentary to make out, but seem to belong to some species of the *Lycænidæ*.
„ 10. Half of fore-wing of *Charaxes* sp. ?.
„ 11. Portion of hind-wing of *Symphædra dirtea* ♀.
„ 12 to 17 are the wings of dragon-flies."*

A passage from another letter of Mr. de Nicéville to Colonel Bingham indicates in a different manner the severity of the nearly unseen struggle for existence which butterflies of certain genera pass through. The wings sent by Col. Bingham were found by him in 1888. Mr. de Nicéville wrote concerning them:—

"See p. 275 of vol. ii of my 'Butterflies.' Ferguson found a single wing of *Charaxes schreiberi* in Travancore on the ground. It is curious that the only record so far of the

* In the *Zoologist* (4th Series, vol. v, 1901, pp. 224, 225) Colonel Bingham states that he found, on April 23, 1899, a nest of the same species of pigmy falcon in a hole on the under-side of a branch of a dead tree in a deserted taungyah alongside the high-road leading from Thabeitkyin, on the banks of the Irrawaddy above Mandalay, to Mogok, the site of the famous Ruby Mines of Upper Burma. The hole had evidently been made by a Barbet. It was 15 inches long, and at the end was slightly enlarged into an oval chamber containing "a fairly firm pad of chips of wood, a few leaves, with an upper stratum quite two inches thick, composed almost entirely of the wings of cicadas, with a few butterfly and moth wings interspersed therein." There were no eggs or nestlings. "Further south, in Tenasserim," Colonel Bingham continues (l. c. p. 225), "I found the eggs of this falcon in a precisely similar situation early in April, as well as I can remember. That nest was composed almost entirely of butterfly wings." Colonel Bingham informs me that the last-named nest was the one, described above in the text, which was found in March 1878, and furnished the wings named by de Nicéville.

same species from Burma should be the three wings you send me, which you say you found on the ground."—E. B. P.]

15. Guy A. K. Marshall's Indirect Evidence of the Attacks upon Butterflies. (E. B. P.)

At the meeting of the Entomological Society held on August 1, 1883, Professor Meldola communicated some observations made by Dr. Fritz Müller in Brazil (Proc. Ent. Soc. Lond., p. xxiii), together with specimens of distasteful conspicuous butterflies with wings notched or otherwise injured apparently by birds. Dr. Fritz Müller's well-known theory, which accounts for synaposematic resemblances, implies that even distasteful butterflies are experimentally attacked by young enemies. That such attacks are made had been doubted, and Professor Meldola therefore wrote to Dr. Müller asking him to collect observations upon the point. A specimen of *Heliconius cucrate* sent by him to Professor Meldola was described (Ann. Mag. Nat. Hist., Dec. 1882, p. 419) as having a symmetrical, jagged notch on both fore-wings; and on Aug. 1, 1883, Professor Meldola exhibited examples of thirty-six notched and shorn specimens of *Acræa* [*Actinote*] *thalia*, obtained in one week by the great German naturalist. These examples and the *Heliconius* have been presented by Professor Meldola to the Hope Department, where they may be seen beside numerous similar specimens from very different parts of the world, including those figured on the accompanying Plates IX, X, and XI. Similar observations upon Bornean butterflies, including four *Danainæ*, have been published by S. B. J. Skertchley (Ann. Mag. Nat. Hist. (6) iii, 1889, pp. 477–485), while W. L. Distant has described unsymmetrical injuries, apparently caused by a bird, in the wings of *Limnas chrysippus* ("Naturalist in Transvaal," 1889, p. 65). I noticed the same thing (1888) in many specimens of *Colias edusa* captured in Madeira ("Colours of Animals," London, 1890, p. 206; see also Roland Trimen's Presidential Address to the Entomological Society of London, Jan. 19, 1898, where many of these and other records are collected and commented upon).

It seemed of importance to obtain this kind of evidence from as many parts of the world as possible and on a large scale. I therefore asked Mr. Marshall if he would kindly

look out for specimens of butterflies bearing injuries which were probably caused by birds or other enemies. The results, as in every other instance in which I have asked for his help, far exceeded my most sanguine hopes. He sent me the fine series of injured specimens represented on Plates IX, X, and XI.

Looking at the species represented in this collection one is at once struck with the repetition of the very forms which have been seen to be attacked by birds (see pp. 357 to 359). Thus *Atella phalantha*, once *seen* to be mutilated by a bird (p. 357), is represented by no less than five injured specimens (Plate IX, figs. 9 and 12; Plate X, figs. 2, 4, and 5). And nearly every other species observed to be attacked or found in the stomach of a bird is also represented, often by two or more examples, in the three accompanying plates.

The presence of specially-protected forms, *Danainæ* and *Acræinæ*, is as conspicuous as in the observations made in other parts of the world; but new and interesting light is thrown upon the problem by the examination of these specimens and comparison with those of other more palatable groups. A large proportion of the former (Plate IX, figs. 1, 5, 7, 10, 11) are far more extensively mutilated than any but exceptional instances among the latter, and remarking the peculiar toughness, flexibility, and power of recovery in the wings of *Danainæ* and *Acræinæ*, we are driven to the probable conclusion that the results are in many cases those of experimental trials by young enemies and heroic attempts on the part of extremely hungry enemies, rather than unavailing efforts at the capture of palatable prey. The futile attempts of hungry animals, accompanied by extensive mutilation of unpalatable insects, are well known in confinement (Proc. Zool. Soc., 1887, p. 191), and Mr. Marshall has made observations of the same kind upon insect enemies in the wild state (see pp. 318, 358, 359).

The conclusion that butterflies may be pursued when specially easy to catch, suggested by the observations on April 26, 1899 (p. 358), is somewhat confirmed by the curious fact that all the five examples of *Limnas chrysippus* are females (Plate IX, figs. 1, 5, 10, and 11; Plate X, fig. 1).

Of the conspicuous wet phases of the seasonally dimorphic *Precis* only a single example is present (Plate IX, fig. 24),

whereas six examples of the cryptic dry phase are included in the series (Plate IX, figs. 15, 19, and 23; Plate XI, figs. 1, 2, and 4). These facts may possibly lend some support to the suggested interpretation of these remarkable changes (see pp. 431 to 442).

Some naturalists may be inclined to interpret the injuries represented on Plates IX, X, and XI as the ordinary results of age and wear, or the accidental contact with thorns or twigs. Such an explanation is not consistent with the fact that the great majority of the specimens are in other respects fresh and unworn, and the margins of the wings not frayed as they become in individuals which have been long upon the wing. Again, the very high proportion of the injuries inflicted at the anal angle and along the hind margin of the hind-wing is inconsistent with any such interpretation. The part of the wing surface which is certain to come most in contact with foreign objects is the apical angle of the fore-wing, next, the costal and hind margins of the fore-wing, last of all the border of the hind-wing which is behind, and, as the insect finds its way through an interlacing meshwork of twigs and leaves, is defended by the greater width and powerful costa of the fore-wings. It is true that the apex of one or both fore-wings is not uncommonly snipped off, several examples being represented on Plate IX, and in the four lowest figures on Plate XI, but the great majority of the specimens captured by Mr. Marshall will be found to be injured in the hind-wing. And of those snipped or notched in the fore-wing, some exhibit symmetrical injuries which clearly suggest that the insect was seized with the wings together, probably at rest. Figs. 12 and 17 on Plate IX are good examples. Equally symmetrical injuries are also common on the hind-wings, either taking the form of a snip which suggests the very shape of a bird's bill (*e. g.* Figs. 4, 30, 31, 33 on Plate X), or one in which both anal angles or even a large part of both hind-wings are shorn completely off (*e. g.* Figs. 2 and 28 on Plate X; Figs. 8, 9, 18 and 20 on Plate XI).

In one very interesting example of *Vanessa atalanta* from N. Devon, presented by Dr. F. A. Dixey to the Hope Department, there is only one possible position in which the injury could have been inflicted, viz. the position shown in Fig. 31, Plate X, for in that position alone can the snip *in all four wings* be made to coincide. Furthermore, the position is that of complete repose, when the

white patch on the costal border of the under-side of one hind-wing, wrapping round the front of the costa of the fore-wing, meets the corresponding patch on the opposite side, and is distinctly seen from the front. The specimen captured by Mr. A. H. Hamm, represented in the adjacent Fig. 33, was probably seized soon after it had alighted, when the wings were held in the manner indicated in the figure, and before they were lowered between the hind-wings in the attitude of repose. Or it is possible that this specimen was seized during flight at the moment when the wings came together.

The theory of probability prevents the interpretation of any but very rare symmetrical notches, except on the supposition that the wings were together at the time of the injury, and when the condition of the specimen is fresh and the notch possesses a definite and similar shape, fitting that upon the opposite side, there can be no hesitation in inferring the attack of an enemy.

Turning to unilateral injuries, of which many examples will be found in Plates IX, X, and XI, Mr. Marshall is of opinion that they are the strongest evidence of the attacks of birds because they were almost certainly inflicted while the insect was upon the wing. Perfectly fresh specimens with such injuries of a very pronounced type are shown on Plate IX, figs. 15, 19, and 23; Plate X, figs. 1, 3, 5, 19, 25, 29, etc.; Plate XI, figs. 4, 6, 7, 11, etc. It is true that a butterfly settled upon a flower with outspread wings might be seized by one side; but insects in that position are on the alert, and many butterflies when slightly disturbed will shut their wings with a snap when they do not take flight.

Looking at the injuries as a whole it is seen that the great majority are inflicted at the anal angle and adjacent hind margin of the hind-wing, a considerable number at or near the apical angle of the fore-wing, and comparatively few between these points, at or near the inner angles of the wings. I was at first greatly struck by the comparative rarity of injuries in the last position, but in a later consignment Mr. Marshall forwarded many excellent examples, referred to in the following paragraph:—

"*Salisbury, Sept.* 27, 1901.—It was curious that just after getting a letter from you, pointing out the greater rarity of mutilation at the inner angles, I came across quite a succession of excellent examples of this form. The

*Teracolus omphale* is of special interest, as I think the attack can only have been made by a bird. The same applies to the *Nyctemera*, for this insect invariably conceals its hind-wings when settled, dropping immediately into this position as it alights. I have occasionally observed that it holds its wings over its back for a very short time before closing them. I think the damage to the hind-wings must be the result of two separate snaps from a bird while the moth was on the wing."

The specimen of *Teracolus omphale* was accidentally omitted from the illustrations, but the *Nyctemera* is shown on Plate X, fig. 8, and three of the best examples of injury at an inner angle on Plates IX, figs. 15, 19, and 23.

If it be granted that the injuries shown on Plates IX, X, and XI are chiefly if not entirely due to enemies, the question as to the kind of enemy remains to be settled. The only probable foes are birds, reptiles, especially lizards, and mantides. It is therefore of importance to show that injuries entirely similar in character to those upon Mr. Marshall's South African captures, are also found on butterflies from parts of the Holarctic Belt where mantides do not exist and the attacks of lizards amount to so little that they may be safely neglected.

I have therefore included (on Plate X, figs. 26 and 28 to 33) the representation of a few butterflies with snipped wings from the Northern United States, Switzerland, and England. These are only a selection from a much larger amount of material of this kind in the Hope Department, but sufficient to show that the character of the injuries in the northern land belt is the same as that of those far south of the Equator, and in a country where lizards and mantides are very important foes.

Much however may be determined by the character of the injury and the habits of the butterflies. Such an injury as that shown on Plate X, fig. 4, for example, is hardly likely to have been caused by anything but the beak of a bird. When a mantis seizes a butterfly with its raptorial legs the wings are instantly crumpled and at the same time torn and scratched with the thorn-like spines. Only two or three specimens out of the 82 here figured bear any such traces, viz. Plate I, figs. 7, 11, and Plate XI, fig. 5, and in these cases the interpretation is very far from certain. With regard to lizards, butterflies which settle on low flowers, and especially those which alight

on the ground and rocks, are very liable to be attacked, but in South Africa at least, species which haunt bushes and trees and fly high are not likely to fall a prey to lizards, and birds are the only probable enemies when no traces have been left by a mantis. In the description of Plates IX, X, and XI, a brief account of the habits of each South African species is given by Mr. Marshall together with the conclusion which appears to be justified.

A very interesting general conclusion emerges after this consideration and comparison of all the specimens here figured, viz. the bionomic meaning of important elements in pattern, and important structural developments of the wings of Lepidoptera. On Plate IX we see evidence that injury at the apical angle of one or both fore-wings is fairly common. Now this angle is very remote from the vital parts, and no great harm to the butterfly is done by such injury. And this is a part of the wing which is constantly rendered specially conspicuous below as well as above by apical and sub-apical white spots and bars, black tips, patches of bright colour, and by eye-spots (Plate IX, figs. 1, 3, 15, 16, 20, 21, 22, 23, 25; Plate X, figs. 3, 8, 19, 25, 28, 32, 33; Plate XI, figs. 4, 21, 22, 23, 24). In the four lowest figures on Plate XI the conspicuous apical marking has been injured and, in three cases out of four, partially or entirely shorn off on one side. This interpretation of the meaning of the apical colour-patches was suggested by Mr. Marshall in sending these very specimens, and he alluded to two out of the three butterflies figured on Plate XI, figs. 21–23, in the following passage:—

"*Salisbury, June* 20, 1899.—I would suggest that these bright patches of colour [in the orange- and purple-tipped *Teracoli*], which were doubtless first developed by sexual selection, have been of further use in diverting attack from the vital parts, and this may perhaps explain their almost universal transmission to the female sex. I have sent you two good examples supporting this view, in that the orange tip of one wing has been snipped off, presumably by a bird. It should however be noted that the *purple* tips are very inconspicuous in flight, and perhaps this might account for the markedly-swifter flight of those species which possess them, as they will have thus lost a useful protection through the action of sexual selection, and have compensated it by increased swiftness." *

* Dr. F. A. Dixey points out to me that it is in favour of this

Notches close to and sometimes involving the same kind of markings are to be seen on Plate IX, figs. 1, 3, 5, 10, 16, 19, and 21.

We can thus understand the conspicuous apical markings of the fore-wings of butterflies, together with the common prolongation of the apex of the wing, as directive marks which tend to divert the attention of an enemy from more vital parts.

The comparison of Figs. 31 and 33 on Plate X will show a common method in the use of this marking on the under-side. It is exposed for a few seconds after the butterfly alights (Fig. 33), and then hidden by lowering the fore-wings between the hind (Fig. 31). The meaning is no doubt that which is suggested on pp. 440, 441, where it is however applied to the case of those sub-apical eye-spots on the under-side (Plate X, figs. 28 and 32) which are exposed and then hidden in a similar manner.

Since the above sentence was written I have consulted my assistants, Mr. W. Holland and Mr. A. H. Hamm, who have had great experience in the ways of British Lepidoptera, and they both agree with me that our species of *Satyrinæ* with special sub-apical eye-spots on the under-side of the fore-wing are apt to expose these marks for a few seconds after alighting, and then swiftly cover them by lowering the fore-wings between the hind. The "Grayling," *Satyrus semele*, is particularly noticeable in this respect, as all three of us have often observed; but the movement is well seen in our other species with similarly-placed eye-spots.* This characteristic movement considered in relation to Mr. Marshall's injured specimens, and to the experiment with a lizard mentioned on pp. 440–1, and a kestrel on p. 341, places the hypothesis advanced on the former pages in a satisfactory position.

But the interpretation of markings and structures at or

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interpretation that the *females* of the species with purple-tipped males are themselves often orange-tipped.

* Dr. Dixey has specially observed this movement in *semele*. He states that *Epinephele janira*, on the other hand, usually shows the eye-spot when resting by day, although it quite conceals it when settling down in the evening: while a ♀ *E. tithonus*, settled on a bramble-leaf in sunshine, exposed the ocellus, but concealed it when a cloud came over the sun, again uncovering it when the cloud passed. Dr. Dixey's notes were made at the time of the observations at Morthoe, North Devon, in 1897–8.

near the anal angle of the hind-wing is even more convincing, inasmuch as both markings and structures are far more specialized and examples of their injury much commoner. Plate X is entirely occupied with the representation of such injuries in species which are without special directive marks and structures at this region of the hind-wing, while Plate XI, with the exception of the four lowest figures (21 to 24) and figure 4, is devoted to the illustration of injuries received at the very spot which has been rendered specially conspicuous. In fact, on Plate IX we have evidence that the attacks of enemies are common at the apical angle of the fore-wing, and on this Plate as well as in the four lowest figures of Plate XI the special directive marks developed at this specially-exposed area are seen to be shorn off or in some way injured; while on Plate X we have the same kind of evidence of still more frequent attack at the anal angle of the hind-wing, together with, on Plate XI, the evidence that this general tendency on the part of the enemy is encouraged by the development of directive features of all kinds, which are shown to be successful in that they have been attacked. We see on Plate XI the prolonged "tails" of the hind-wings of *Precis* shorn off (Fig. 1), together with the large eye-spot marking the same region in *Papilio demodocus* (Figs. 8 and 9), the two "tails" of *Charaxes* (Figs. 5, 10, 13, 14, 15, 20), the slender single "tail" with its accompanying single or double eye-spot of some *Lycænidæ* (Figs. 6, 11, 16, 17), the conspicuous lobes combined with one or two "tails" and bright spots, sometimes in the form of eye-spots, of other *Lycænidæ* (Figs. 3, 7, 12, 18, 19).

Many beautifully "tailed" forms occur among the *Nymphalinæ* of tropical America, such as *Protogonius*, *Anæa*, etc., and the commonly developed "tails" of Papilios are probably to be explained in the same manner. When a "tail" is produced at the anal angle of the hind-wing in relation to a dead-leaf-like under-side, the mid-rib-like stripe is developed in relation to the apparent leaf stalk, as is seen in Plate XIII, figs. 4a, 4b, 6, 7, and 8. On the other hand, Fig. 1 on Plate XI shows well that such "tails" may also act as advantageous directive structures.

The resemblance of the marks and structures at the anal angle of the hind-wing under-side in many *Lycænidæ* to a head with antennæ and eyes has been independently noticed by many observers. The movements of the hind-

wings by which the "tails," the apparent antennæ, are made continually to pass and repass each other, add very greatly to this resemblance. The head-like appearance, first observed by Dr. Arnold in *Thecla iarbas* and confirmed in other species by Dr. Forsström, is quoted by Kirby and Spence (People's Edition, 1867, p. 423): it was independently observed by Mr. R. C. L. Perkins ("Colours of Animals," London, 1890, p. 208) in *Thecla W-album*, and this keen naturalist obtained confirmatory evidence in the case of the English *Thecla*, similar to that shown upon Plate XI. My friend Dr. Richard Evans of the Museum at Georgetown, British Guiana, independently observed the same thing in Siam, when taking part in the Skeat Expedition. My friend Professor Wyndham R. Dunstan, F.R.S., sending me a pair of *Deudorix antalus* bred from larvæ which are destructive to the pods of "*Inga dulcis*" at Manashi, near Cairo, wrote (July 4, 1900) that his friend Mr. E. A. Floyer who sent the insects "remarks that the butterfly has markings on its tail which resemble the head. He considers this protective, as a bird is uncertain which is the head and which is the tail, and the insect often escapes by going off in the unexpected direction." My friend Mr. Champion B. Russell, who presented to the Hope Department the beautifully mutilated specimen of *Spindasis natalensis* represented on Plate XI, fig. 3, also independently recognized the same resemblance (1900), and thought that the lobes with their two tails passing and repassing each other looked like jaws opening and shutting. I asked Mr. Marshall's opinion on this subject and received the following reply:—

"*Salisbury, June* 11, 1901.—Mr. Russell's observations on the tails of *Lycænidæ* are, as you say, of considerable value as coming from an entirely independent source, but I must confess that I am not inclined to believe that the anal appendages in the wings of butterflies have been modified in imitation of particular organs, for I fail to see how this could be effected by ordinary selection. And I think a valid argument against such an idea is the great diversity of form shown by these appendages, not only among the *Lycænidæ* but other families as well. It seems safer to regard these curious lobes and tails as having been developed by natural selection for the purpose of attracting attention to that part, and that the particular form they take is due to congenital variations which we cannot

at present explain. As a matter of fact there seem to be really very few "blues" in which the tails bear any real resemblance to antennæ. Again, so far as the special explanation of jaws is concerned it seems to me that this would rather prompt a bird or lizard to attack the insect at the other end, which would be fatal. In some cases there appears to be a possibility of explaining the particular shape of a tail; for example, in *Charaxes* the general rule is two thin tails on each wing, and we can understand that this would not be suitable for the leaf-like under-side of *C. varanes*, which has consequently developed a single thick tail which is more in keeping with its style of coloration. Again, the thick twisted tail of *Myrina* greatly enhances its general resemblance to a bit of shrivelled fig-leaf, and so forth."

I think, however, that it is probable that such resemblance as there is to a head, in certain species of *Lycænidæ* may be of value and may have been produced by direct selective action, and I would specially draw attention to Mr. Floyer's suggestion (p. 374) that the butterfly may dart off in a direction which the head-like appearance has caused to be unexpected by an enemy. Many years ago my friend Dr. A. C. Haddon, F.R.S., showed me a specimen of a little yellow fish, about $1\frac{1}{4}$ inches long, which he had observed and captured among coral, Aug. 11, 1888, at Thursday Island, Torres Straits. The head was crossed by a dark, white-bordered, vertical, somewhat curved band, which included the eye and tended to conceal it. At the root of the tail was a very conspicuous eye-like mark. The fish had the habit of often swimming for a little distance very slowly tail first, but if disturbed it would dart off with great rapidity in the opposite direction, viz. head first. That so similar an adaptation should be met with in such a very different part of the animal kingdom affords considerable indirect support to the interpretation of these Lycænid marks and structures, at which so many naturalists have independently arrived. Dr. Haddon kindly permits me to make use of his interesting observation, which has not been hitherto recorded. Mr. G. A. Boulenger, F.R.S., informs me that the fish is *Chætodon plebeius*.

16. Experiments on a Captive Mungoose (*Herpestes galera*) with Insect-food. (G. A. K. M.)

1899.

May 27. Offered a *Rhopalocampta forestan* to a very young female Mungoose (*Herpestes galera*); she rushed at it, but on touching it with her nose drew back sharply (her eyesight was still but feeble); so I partially cut off its wings and let it flutter on the floor, whereupon she ran at it several times but did not attempt to eat it. I then gave her four *T. senegalensis* (without wings) which she ate greedily, and on being offered a *Mylothris agathina* she promptly seized it, but immediately jumped back so violently that she rolled head over heels. The way she shook her head clearly demonstrated the distastefulness of the butterfly, and she would not let me bring it anywhere near her. I then offered a *Belenois mesentina*, but with the same result; she refused to touch it every time. Thinking this might be due to her experience with the *Mylothris*, I put the *Belenois* aside and offered it ten minutes later, when it was eaten with undoubted relish. An *Acræa caldarena* and *A. axina* were then refused, but without being tasted, the smell being apparently quite sufficient. More than an hour afterwards I again tried her with *R. forestan*, but she would not touch it, though whether this was due to fear of its size and violent fluttering, or to some unpleasant smell, I could not well decide; any way she did not attempt to bite it.

June 3. Gave mungoose two *Terias brigitta*, two *Teracolus omphale*, and two *Belenois severina*. All these had their wings cut off and were thrown on the ground, when they were promptly seized and eaten. A *Mylothris agathina* was then offered in the same manner, and even this was eaten.

June 4. Mungoose ate three *Terias brigitta*, three *T. senegalensis*, two *Precis sesamus*, three *Byblia ilithyia*, one *Pyramcis cardui*, and two *Mylothris agathina*.

„ 7. Mungoose ate three *Acræa axina* and actually one *Limnas chrysippus*. Whether this eating of evidently-unpalatable species is due to the voracious appetite of the animal or to a youthful lack of discrimination it is difficult to say, but probably the former is the truer explanation. I could not observe any marked signs of its having found the insects unpleasant.

„ 11. Gave mungoose an *Acræa caldarena*, which was promptly eaten. An *L. chrysippus* was then thrown down; she seized it at once, but quickly ejected it with unmistakable signs of distaste. An *A. axina* was treated in a precisely similar manner, so that she seemed to have learned wisdom. Later on she was offered a *Phymateus morbillosus;* she made several attempts to eat it, but its very unpleasant smell deterred her each time.

[These results are interesting and in some respects remarkable. It is probable that some of the apparently-inconsistent results were due to the fact that a voracious insect-eater in extreme youth was gaining its first experience of certain species. Thus the apparent fear of the large Hesperid *Rhopalocampta* was probably, as Mr. Marshall suggests, the inherent timidity of a young animal in the presence of a strange sound and a method of wing-vibration very different from anything which it had witnessed before. The treatment of *Mylothris* suggests that the animal was startled at first by something unusual in taste or smell, but that when it became accustomed to the experience the Pierine was no better defended against the mungoose than against mantides. On the other hand, the behaviour towards Acræas and *chrysippus* seems to indicate a progressive recognition of distastefulness or unwholesome qualities. It is unfortunate that the experiments were not greatly extended and prolonged.—E. B. P.]

17. Experiments on a Captive Mungoose with Bird-food. Warning Characters and distasteful Qualities in South African Birds. (G. A. K. M.)

[Although this section is strictly speaking outside the scope of the present memoir, it is so closely associated that I have ventured to include it.

Mr. Frank Finn noticed that his mungoose, *Crossarchus fasciatus*, "appeared to be unwilling to attack birds, though it did not seem to find them unpalatable" ("Natural Science," vol. i, No. 10, December 1892, p. 746).—E. B. P.]

*Salisbury, Jan.* 24, 1900.—I have been recently giving my mungoose some wild birds, and I was much interested to note the result. It ate a dove (*Turtur capicola*), standard wing night-jar (*Cosmetornis vexillarius*), dwarf goose (*Nettapus auritus*), moorhen (*Gallinula chloropus*), and wheatear (*Saxicola pileata*); while it emphatically refused an owl (*Asio capensis*), kestrel (*Cerchneis rupicoloides*), buff-backed egret (*Herodias lucidus*), hobby (*Falco subbuteo*), and drongo (*Buchanga assimilis*). Its dislike of the smell of the common and conspicuous blue-and-black drongo was very marked, especially as it was hungry at the time, and I had plucked the bird clean; it made one or two attempts to eat the meat, but finally gave it up. In the case of this bird and the egret we would therefore seem to have a case of true warning coloration. This is also probably the case with the wood-hoopoes (*Irrisor* and *Rhinopomastus*), which are very conspicuous both in voice and colour—the latter being in both genera black shot with metallic dark-blue or green, with a large white speculum in the wing, and a long tail.

*Salisbury, June* 26, 1900.—As to distastefulness in birds I must further mention our wood-hoopoes, *Irrisor viridis* and *Rhinopomastus cyanomelas*, both of which emit a strong unpleasant smell. They are both metallic greenish-blue birds with long fan-like tails and a conspicuous white bar on the wings, differing principally in the shape and colouring of the beak. They are also both very noisy, frequently uttering their harsh, chattering cries, and especially when alarmed. Another bird which has well-known distasteful qualities is the ground horn-bill (*Bucorax caffer*). Indeed the Zulus use it on that account for rain-making; they will kill one and throw it into a river, for they say its smell makes the river sick, so that it calls

down the rain to enable it to wash the body away. This bird is black all over with only the primaries white, and is so weak on the wing that after three or four flights a good runner can run it down.

### 18. Experiments on *Cercopithecus pygerythrus*. (G. A. K. M.)

The following experiments were all made at one time, in February 1902, at Salisbury. The insects were offered in the following order:—

*Psiloptera chalcophoroides:* regarded with some suspicion; its head bitten off, and the remainder examined and eaten cautiously.

*Amblysterna vittipennis:* was offered and eaten at once.

*Praogena splendens:* was smelt and at once thrown away.

*Dichtha inflata:* was cautiously smelt and refused.

*Amblysterna vittipennis:* was regarded with great suspicion, carefully examined and then eaten slowly.

*Precis sesamus* (*natalensis* form): was received with suspicion and very slowly eaten.

*Precis pelasgis*, *P. sesamus* (*natalensis*), *Byblia acheloia*, and two *Precis antilope* were then eaten readily, but evidently not so much appreciated as the beetles.

*Acræa haludi* was then accepted without suspicion, but when the monkey put it in his mouth, he at once took it out again and looked at it with the utmost surprise for some seconds, and then threw it away. He would have nothing to do with an *A. caldarena* which I then offered him.

[Mr. Marshall was greatly struck with the caution and hesitancy displayed by the monkey, and the evident effect of distasteful forms in causing suspicion of palatable species offered immediately afterwards. I have noticed the same thing with the marmoset ("Colours of Animals," London, 1900, pp. 241, 242).

The refusal of the two Heteromerous Coleoptera, the acceptance of the cryptic species, and the treatment of the Lepidoptera, are in general correspondence with the results obtained in other experiments.—E. B. P.]

## 19. Experiments on Captive Baboons. (G. A. K. M.)

### *Lepidoptera Rhopalocera.*

| ACCEPTED. | REFUSED. |
|---|---|
| *P. cardui*, *R. forestan*, *J. cebrene*, *B. severina*, *C. florella*, *T. achine* (apparently with doubt, the first specimen being rejected at sight but eaten immediately afterwards, others eaten at once).<br>One *P. corinneus* (taken with suspicion, pulled to pieces and thrown away, then picked up, smelt, and eaten). | *A. halali*, *A. axina* (recognized and refused untasted), *L. chrysippus* (tasted and rejected), *Protoparce convolvuli* (seized eagerly by the female, but on smelling it she regarded it with suspicion; she rubbed it about on the ground and then pulled it to pieces, smelling and rejecting each piece). |

A *P. sesamus* ⊕ was pulled to pieces and rejected by the female, but the remains were eaten by the male; each subsequently ate another specimen. *B. ilithyia* refused by female but eaten by male; female ate the second one offered. *C. florella* eaten readily by both. *A. halali* rejected by female at sight, tasted and rejected by male. *L. chrysippus* tasted and rejected by male.

### *Coleoptera.*

| ACCEPTED. | REFUSED. |
|---|---|
| *Polyhirma æniyma* (with doubt at first); *Peploptera anchoralis*, Jac. (rejected at first and rubbed on the ground, but eaten immediately afterwards); five *Piezia marshalli* (eaten readily); *Polycleis longicornis* and *P. equestris*; *Adoretus flavcolus*; *Graphipterus mashunus*; *Piezia selousi*; *Polyhirma boucardi* and *P. semisuturata*; *Graphipterus tibialis*; *Anomala*, n. sp.; one *Anomalipus plebeius*; *Brachycerus brevicostatus*; *Sternocera funebris*; *Psiloptera chalcophoroides*; *Peploptera zambesiana*; *Micrantereus carinatus*. | *Gymnoplcurus smaragdinus*; *Onitis alexis*; *Epilachna dregei*; *Anthia thoracica* (evidently recognized at once; the baboon seized and flung it on the ground, rubbing it violently, with averted head, as though to kill it); *Clinteria infuscata*; *Praogena festiva*; *Chilomenes lunata*; *Pachnoda flaviventris*; *Onthophagus gazella*; *Mylabris palliata*; *Diacantha conifera*; *Protætia amakosa*; *Zonitis*, sp.; *Plagiodera thoracica*; *Lycus ampliatus*; *L. subtrabeatus*; *L. constrictus*; *L. rostratus*.<br>A *Mutilla* offered twice but evidently recognized and refused (*Polyhirma æniyma* eaten immediately afterwards with scarcely any hesitation). *Eletica rufa* (with evident disgust); *Malacosoma discoidalis*, Jac.; *Prionocerus dimidiatus*; *Decatoma lunata* and *M. tettensis*; *Onitis innuus*; *Oniticellus militaris*; and *Pachnoda rufa* all refused at sight. |

Four *Protaetia amakosa* and four *Oxythyrea dysenterica* were refused by female at first but eaten rapidly by male. The female eventually ate one of the latter, but evidently in doubt.

The above experiments were conducted at Salisbury in December 1898.

1899.

Jan. 7. *Psilopterœ* are all eaten readily by baboons.

„ 28. *Byblia ilithyia* eaten by young baboon (*Papio parcarius*). A *Clythra wahlbergi* was offered to baboon, but immediately refused on being smelt (it has a *very* decided *Coccinella*-like odour). The Coccinellid *Epilachna dregei* was refused.

„ 29. Offered the Longicorn, *Ceroplesis fallax*, to the baboon, which smelt it and shook his head, showing evident alarm when the insect stridulated; on my pulling off the head he took the body and pulled it to pieces, smelling each part, but would not eat it. I then offered him a large brightly-coloured Cetoniid, *Cœlorrhina loricata;* its strong smell was clearly distasteful to him, so I put the insect on his hand; he was much frightened and tried to shake it off, but could not, owing to its long claws, and was thoroughly terrified by the loud buzzing it made as it finally flew off. Offered *Piezia selousi* to the baboon; I could tell by the way that he tried to snatch sharply at it that he recognized it, and when he did seize it he threw it violently on the ground, rubbing it with his hands (as is their custom with distasteful insects). I picked it up and gave it to him again; he then ate the head, took a bite out of the abdomen and threw the rest away.

Feb. 1. Another young baboon ate two *B. severina* and two *B. mesentina* with evident relish. It then refused *Onitis alexis* at sight and would not even touch it. An example of *Anomalipus plebeius* was then taken, smelt

and thrown away, although I can detect no smell in this species, which, however, stridulates strongly by rubbing the head against the thorax.

Feb. 14. Baboon ate one *Colias electra* and one *Byblia ilithyia*. It tasted and rejected first an *A. caldarena*, then an *L. chrysippus*, then rejected at sight several *A. axina* and *A. halali*.

„ 15. Gave female baboon two *Teracolus achine*, which she ate with appreciation. A *Mylothris agathina* was taken with some doubt, the head and thorax were eaten and a small part of the abdomen, the rest being thrown away; it was clearly not much appreciated. An *L. chrysippus* was tasted and refused. Then an *Acræa anemosa* was offered with under-side exposed to show the bright red and black markings; it was tasted and refused. A *Precis sesamus* ⊕ was then offered in precisely the same manner; the baboon took it, held it in her hand for a few moments and then let it fly away without attempting to smell or taste it. I then cut the wings off another specimen of the same insect, and this was promptly eaten without any signs of distaste. This appears very significant. Then two *Limnas chrysippus* and one *Acræa anemosa* were refused at sight without trial; one *Neptis agatha* was tasted and neglected, and two *Belenois severina* were eaten.

„ 18. Baboons ate with great avidity two *Anoplocnemis curvipes*, a large strong-smelling Hemipteron all brown in colour. They would have nothing to do with a *Mylabris dicincta* or a *M. tettensis*.

„ 20. Baboons ate readily four *Brachycerus brevicostatus*, one *Psammodes scabratus*, one *Chlænius cylindricollis*, one *Tragiscoschema wahlbergi*, and also an imago and nymph of the very large and evil-smelling Hemipteron *Petascelis remipes*.

A *Blepisanis haroldi* which was offered to one was taken, immediately thrown down without even being smelt; on re-presentation it was smelt and tasted cautiously, found to be palatable, and eaten; there can be little doubt that it was mistaken for one of the synaposematic members of the powerful Lycoid group. A larva of *Precis sesamus* was neglected by both baboons, neither taking the slightest interest in it.

Feb. 24. Baboons ate greedily two *Anoplocnemis curvipes*. As I was taking an *Anthia massilicata* out of a box the male baboon made a snap at it and received a good dose of its powerful acid in his mouth, which made him start back in a great fright, making most comical grimaces; I then offered the beetle piecemeal to the other baboon, and it was eaten with relish except the anal portion of the abdomen, which was rejected. This is of interest in connection with the immediate recognition and violent rejection of *A. thoracica* by the female in an earlier experiment. One *Catopsilia florella* and three *Terias brigitta* were next eaten. Then two *Byblia ilithyia* were offered with the upper-side exposed, and were eaten with undoubted appreciation by the female; I then showed her a large brightly-coloured example of *Acræa rahira*, also exposing the upper-side, but she recognized it, merely taking it, pulling its head off and throwing it on the ground without even smelling it. She then ate two more *B. ilithyia*, and finally I offered her an *ilithyia* and an *Acræa axina* together, both having their wings closed and being held close to one another; she took and ate the former, but quite neglected the latter. This experiment tends to show that the general resemblance which *Byblia* bears to an

*Acræa* is not sufficiently close to deceive a baboon.

Feb. 25. Gave baboon a *B. ilithyia*, which was eaten without hesitation, then an *Acræa halali*, which she rubbed in her hands as though preparatory to eating, but eventually threw down without even smelling it; she then ate another *B. ilithyia*.

March 20. Gave baboons three specimens of a brightly-coloured black-and-yellow spider (*Gasteracantha ornata*). They viewed them with some distrust at first, but eventually ate them with appreciation.

„ 22. Baboons ate one *Precis archesia* and two male *Hypolimnas misippus*, but rejected a *Mylothris agathina*. They further ate two *B. ilithyia*, three *Atella phalantha*, and one *Precis sesamus* ⊕. I then offered an *Acræa natalica*, which was seized, smelt, and thrown away; another *P. sesamus* ⊙ was offered immediately afterwards and neglected.

„ 26. Gave baboon a *Mylothris agathina;* she regarded it with some suspicion, but eventually ate it very slowly and evidently did not care about it. I then gave her another specimen; she pulled the abdomen off, smelt at the exuding juices, and after tasting them gingerly with her tongue, threw the insect away. After this two *Belenois severina* were eaten with relish. I then gave her a *Neptis agatha*, and she seemed to hesitate about taking it, and after tasting a portion of the abdomen neglected it. Of a second specimen she ate rather more before throwing it down; the remains I offered to the other baboon; he tasted it and seemed in doubt for some time as to whether it was fit to eat or not, but finally rejected it.

April 9. Gave baboon a female *Hypolimnas misippus*, var. *inaria*, of which I had cut off the

wings; she ate it readily and likewise a *P. sesamus.*

April 22. The female baboon ate with relish a male *Hypolimnas misippus* and a *Precis sesamus* ⊙. I then gave her a *B. ilithyia*, which she pulled to pieces and threw down, but then changed her mind, picked up the thorax and ate it, and immediately afterwards she ate three more examples in quick succession without hesitation. A single *B. ilithyia* given to the male was pulled to pieces and neglected.

„ 23. A *Rhopalocampta forestan* and *R. pisistratas* were eaten with avidity by female baboon; she watched with great eagerness while I opened another box, and was evidently disappointed when I produced a *Belenois mesentina;* she ate it, however, and another after it. She seemed doubtful about a *Herpænia eriphia*, but while she was tasting it the male made a grab at it, and I could not decide whether the insect was really appreciated.

May 1. The female baboon ate a *Papilio corinneus* without any signs of distaste, and likewise a *Belenois mesentina.* She then took a *H. eriphia*, but without eagerness, and pulled it to pieces, tasting it gingerly, and finally rejected three-parts of it. Another *B. mesentina* was then offered and neglected.

„ 21. Offered female baboon a larva of *B. mesentina.* She was clearly afraid of it, snatching it from my hand and throwing it down, but she soon picked it up again and began examining it very cautiously; finally she decided to taste it, and after some consideration came to the conclusion that it was all right. She then eagerly devoured over twenty of them, though it was evident she did not like to feel them wriggling in her hand. I noticed that she almost always squeezed out the excreta of the caterpillars before eating

them. The male was much too frightened to eat them in spite of the example of the female. I then gave a *B. severina* to the female and a *B. mesentina* to the male, both being eaten readily. The female made a grab at my box, seized a *Mylothris agathina* and a *B. mesentina* together and began eating them at the same time; she soon found something was wrong and dropped them, then picked up the *Mylothris*, tasted it and threw it away, eating the *Belenois* afterwards. The male, who had meantime eaten another *B. mesentina*, picked up the discarded *Mylothris*, but on tasting it also at once rejected it. Then four *Teracolus omphale* and three *T. achine* were eaten with undoubted appreciation by both baboons. On giving each a *H. criphia* they were both tasted and rejected; the female ate a *T. phlegyas* and neglected another *H. criphia*.

There can be little doubt as to the distastefulness of this latter insect to a certain extent, but I should be inclined to rank it rather lower than *Mylothris* and about on a par with *Neptis agatha*.

Finally, six *Terias senegalensis* were eaten without any sign of distaste by both baboons, though the insects are too small to be much appreciated by them.

*Salisbury, Sept.* 21, 1900.—I could not yet say what protective character is possessed by the *Ichneumonidæ*, but with the Bracons there can be no doubt that it consists in their having a very strong and unpleasant smell, somewhat resembling that of the *Coccinellidæ*, only rather more pungent. They do not attempt to defend themselves by stinging, and their flight is slow, rendering them very conspicuous on the wing. I gave one of the common red species to my monkey (*Cercopithecus pygerythrus*) the other day. He put it straight into his mouth without smelling it, but soon spat it out again. I then offered the mangled remains to one of the baboons, but she merely smelt and rejected them. It is interesting to note that

the baboons, which eat insects largely, are much more cautious in receiving any food than is the *Cercopithecus*.

20. Conclusions from Experiments on Captive Baboons, Mungoose, and Kestrels. (G. A. K. M.)

[Mr. Marshall's notes on these insectivorous animals were in one series, which I have analyzed for the purpose of this memoir. Hence the following references in his letters deal with the experiments as a whole, except in those instances in which a particular animal is named.—E. B. P.]

*Salisbury, June* 20, 1899.—In view of the above experiments it seems to me impossible to regard such genera as *Terias, Teracolus, Belenois, Byblia*, etc. as unpalatable. I quite agree with your excellent suggestion that distasteful characters probably first arose in the larval stage and were transmitted to the imago, and this view lends further support to the presumed palatability of *Belenois*, for my baboon ate the larvæ with much relish. *Teracolus* likewise I must still regard as a non-distasteful genus, at least so far as the orange- and purple-tipped groups are concerned.

I was much pleased with the undoubted proof of mimicry [in the experiments with baboons] in the case of *Precis sesamus* ⊕, for I do not recollect having seen an account of direct experimental proof before.

With *Byblia* I was not so successful as I had hoped, but I am inclined to attribute the hesitation in accepting this species, which was observed in some instances, to imperfect mimicry. I fully recognize the difficulty in distinguishing in such experiments between Batesian and slightly Müllerian mimics, as either might be received with hesitation at first, though if subsequent specimens were eaten readily (as in the case of *Byblia*) I should think they must be included in the former category.

The eager acceptance of the malodorous Coreid bugs by my baboons came as a very great surprise to me, and several other results in these experiments point to the great danger of generalizing on the unpalatability or otherwise of insects, from the results of experiments on only one kind of animal.

*Salisbury, April* 25, 1899.—I may mention that so far as my experiments go I have no evidence for the unpalatability of *Terias, Teracolus, Belenois, Byblia, Precis*, or *Hypolimnas*, whereas *Mylothris* and *Neptis* are certainly distasteful to some extent.

21. Conclusions from Experiments on Baboons. (E. B. P.)

Some of the most interesting results were those which show the actual working of the principle on which the theory of mimicry depends; especially the twice-repeated experiment with the exposed under-side of the distasteful *Acræa anemosa*, resulting in the escape of the *Precis sesamus* ⊕ with a somewhat similar under-side, while the same species deprived of its wings was readily eaten. At the same time a *P. sesamus* ⊕ was on one occasion rejected by the female without any preparatory display of an *Acræa*. The suspicion of the Lycoid Longicorn, *Blepisanis haroldi*, dispelled when it was tasted, points in the same direction. On the other hand, the baboons were not imposed upon by the resemblance of the Carabid *Polyhirma æniqma* to a *Mutilla*. In the natural state the swiftly-running Carabid would have a much better chance of this pseudaposematic protection than under the conditions of an experiment with captive insect-eaters. *Byblia ilithyia* was similarly distinguished from an *Acræa*; but this by no means proves that the resemblance is not beneficial under natural conditions.

As regards Lepidoptera, the refusal of a *Protoparce convolvuli*, after examination of every fragment of it, is most remarkable. The insect at rest is apparently a beautiful example of cryptic colouring. Further experiments are very desirable.

The *Acræinæ* (*axina, caldarena, rahira, anemosa, halali*) and *L. chrysippus* were never eaten, although sometimes tasted; on many occasions they were recognized at sight, and refused. *Mylothris agathina* was sometimes partly and once completely eaten, but it was usually rejected and evidently unpalatable to them. *Neptis agatha* was also generally tasted and neglected, and never entirely eaten. The Pierine *Herpænia criphia* was also evidently distasteful. Other butterflies which were usually eaten did not appear to be a food which is much appreciated. Thus *B. ilithyia* was sometimes neglected and sometimes only partially eaten; *Teracolus achine* was on one occasion eaten "with doubt," and the same was true of one *Papilio corinneus*. The two large Hesperids of the genus *Rhopalocampta* were, on the other hand, eaten with relish, and the baboon showed evident disappointment on receiving *Belenois*

*mesentina* after them. Apart from these examples of hesitation, disappointment, and refusal in part or complete, the baboons ate many species of *Pierinæ* (*Teracolus, Colias, Terias, Belenois, Catopsilia*) and *Nymphalinæ* (*Junonia, Precis, Pyramcis, Atella, Hypolimnas*), but refused to touch the larva of *Precis sesamus*. Considering what has been already argued about insect-eating animals in confinement, the acceptances (excluding the *Hesperidæ*) probably do not justify the conclusion that the Lepidoptera were palatable, or that they would be sought for in the wild state except under the stress of hunger. The treatment of the larva of *Belenois mesentina* certainly seems to indicate palatability to the baboon, and also that it was a first experience of this caterpillar.

The experiments with Hymenoptera are particularly valuable; for although *Mutillidæ* and *Braconidæ* are so greatly mimicked, there is practically no direct evidence that they are refused by insect-eaters.

The fact that the two large species of Hemiptera were eaten, in one case "with great avidity," is a further example of the failure of a mode of defence which produces a great impression upon man, viz. the emission of an odour offensive to us. The suspicion created by the conspicuous spiders was probably due to unpleasant experiences of insects with a similar combination of colours.

The numerous experiments with Coleoptera are exceptionally interesting. I have below tabulated the results under A, acceptances, and B, rejections. It is seen that the species of the following groups were refused without any exceptions:—*Lycidæ*, *Melyridæ*, *Cantharidæ*, *Coccinellidæ*, and *Scarabeidæ*, while those belonging to the *Rutelidæ*, *Buprestidæ*, and *Curculionidæ* were invariably accepted. The uniform refusal of five species of Scarabeids is somewhat surprising, but all of them possessed iridescent colours. Of the six *Cetoniidæ* offered, four were always refused, two being sometimes rejected and sometimes eaten. The only Phytophaga eaten were two *Clythridæ* of the genus *Peploptera*, and one of these was refused at first. The cryptic Heteromera were accepted, although one of them was smelt and refused on one occasion; the iridescent species was rejected. Longicornia were eaten, except the Cantharid-like *Ceroplesis*, which is probably synaposematic (compare p. 396). The *Carabidæ* were extremely interesting. The acid secretion appears to be their

undoubted defence against baboons as it was against the kestrels (pp. 342–3). Hence the small and medium-sized species were eaten somewhat freely, although with evidence from time to time that the acid was disliked, and, on the other hand, a large species with a greater amount of secretion was avoided, and evidently recognized at sight. Another one being seized, discharged its secretion into the baboon's mouth with immense effect. When however it was killed and offered piecemeal, all the parts except those which contained the acid were eaten by the other baboon. If we allow for the fact that *Carabidæ*, attacked under natural conditions, have a much larger supply of the acid, we must admit that they possess a very powerful defence, and that the meaning of the chief quality which underlies the aposematic appearance of the large species is tolerably clear.

A.—*Colcoptera accepted by Baboons.*

| Group. | Species. | Size and Appearance. |
|---|---|---|
| Carabidæ. | *Piezia marshalli.* | Medium ; black with white lines and patches. |
| | ,, *sclousi* (sometimes treated as if distasteful and only partly eaten). | Largish ; similar coloration to above. |
| | *Polyhirma ænigma* (with doubt at first). | Smallish ; black, white-spotted. |
| | *Polyhirma boucardi.* | Largish ; black with white dorsal thoracic line. |
| | *Polyhirma semisuturata.* | Medium ; black with white lines and patches. |
| | *Graphipterus mashunus.* | Smallish ; black with tawny lines and spots. |
| | *Graphipterus tibialis.* | Small ; grey-brown, with grey linear markings. |
| | *Chlæniuscylindricollis.* | Medium ; green, with yellow margin to elytra and yellow legs. |
| Rutelidæ. | *Anomala*, sp. nov. | Medium ; testaceous. |
| | *Adoretus flavcolus.* | Smallish ; ,, |
| Buprestidæ. | All *Psilopteræ* (including the largish *P. chalcophoroides*). | Cryptic colouring. |
| | *Sternocera funebris.* | Large ; shiny black, with white hairs on thorax. |
| Curculionidæ. | *Brachycerus brevicostatus.* | Large ; cryptic. |
| | *Polycleis longicornis.* | Largish ; black, with yellow spots on elytra. |
| | ,, *equestris*, var. | Largish ; iridescent blue-green with red oblique band on elytra. |

| Group. | Species. | Size and Appearance. |
|---|---|---|
| Heteromera. | *Psammodes scabratus.* | Large ; cryptic. |
| | *Anomalipus plebeius* (once refused after smelling). | Large ; black, often earthy, and probably allocryptic. |
| | *Micrantercus carinatus.* | Medium ; probably earthy and allocryptic female, shining black male. |
| Phytophaga. | *Peploptera anchoralis* (rejected at first). | Medium ; yellow with black spots and bands (*Clythridæ*). |
| | *Peploptera zambesiana.* | Similar to above. |
| Longicornia. | *Tragischoschema wahlbergi.* | Smallish ; black with conspicuous orange markings. |
| | *Blepisanis haroldi.* | Small ; Lycoid. |

## B.—*Coleoptera rejected by Baboons.*

| Group. | Species. | Size and Appearance. |
|---|---|---|
| Lycidæ. | Four species. | Warning coloration characteristic of African *Lycidæ.* |
| Melyridæ. | *Prionocerus dimidiatus.* | Lycoid coloration. |
| Cantharidæ. | *Zonitis* sp. | Characteristic Cantharid and Lycoid (*e. g. M. palliata*, etc.) coloration, orange and black. |
| | *Eletica rufa.* | |
| | *Decatoma lunata.* | |
| | ,, *tettensis.* | |
| | ,, *dicincta.* | |
| | ,, *palliata.* | |
| Coccinellidæ. | *Chilomenes lunata.* | Characteristic Coccinellid coloration. |
| | *Epilachna dregei.* | |
| Phytophaga. | *Malacosoma discoidalis.* | Medium ; nearly black with narrow yellow band at apex, and at base of elytra. |
| | *Diacantha conifera.* | Lycoid coloration. |
| | *Plagiodera thoracica.* | Largish ; red-brown thorax, iridescent blue or green elytra. |
| | *Clythra wahlbergi.* | Medium ; Cantharid type, orange and black. |
| Cetoniidæ. | *Clinteria infuscata.* | Medium ; brown elytra, sometimes black, orange thorax with two black spots. |
| | *Pachnoda flaviventris.* | Large ; greenish-black with orange markings. |
| | ,, *rufa.* | Large ; thorax green, greenish-orange elytra. |
| | *Protætia amakosa* (sometimes eaten). | Smallish ; black with many small white spots. |
| | *Oxythyrea dysenterica* (sometimes eaten). | Smallish ; shining green or blue elytra and red thorax. |
| | *Coelorrhina loricata.* | Largish ; green thorax and scutellum, yellow elytra with 4 black spots ; brick-red head and legs. |
| Scarabæidæ. | *Onitis innuus.* | Largish ; iridescent dark-green. |

| Group. | Species. | Size and Appearance. |
|---|---|---|
| Scarabæidæ. | *Onitis alcxis.* | Medium ; brown elytra and legs, iridescent green thorax and head. |
| | *Onthophagus gazella.* | Smallish ; similar colouring to above. |
| | *Gymnopleurus smaragdinus.* | Small ; iridescent green, blue, or red. |
| | *Oniticellus militaris.* | Small ; probably when fresh iridescent dark-green with orange markings. |
| Heteromera. | *Praogena festiva.* | Medium ; almost black with purplish iridescent reflections on elytra, bluish on thorax. |
| Carabidæ. | *Anthia thoracica.* | Large ; black, white spot on thorax and white margin to elytra. Huge mandibles. |
| | ,, *massilicata* (only eaten when offered piecemeal). | Large ; black with pale margin to elytra. Huge mandibles. |
| Longicornia. | *Ceroplesis fallax.* | Large ; black, yellow-banded, Cantharid type. |

## 22. The Chief Conspicuous Specially-Defended Groups in the Coleoptera inferred from G. A. K. Marshall's Experiments. A Comparison between Coleoptera and Lepidoptera in this Respect. (E. B. P.)

It is of great interest to attempt to conclude from the results of the experiments on the palatability of conspicuous Coleoptera contained in this memoir, and from previously recorded observations and experiments on the same order of insects, what are the chief specially defended groups which may be considered to stand in the same position towards their allies as the *Ithomiinæ*, *Danainæ*, *Heliconiinæ* and *Acræinæ* do to the rest of the Rhopalocera, and the *Agaristidæ*, *Syntomidæ*, *Zygænidæ*, etc., do to the rest of the Heterocera.

The chief memoirs upon which the conclusions stated below have been based are published in the Transactions of the Entomological Society of London. They are the papers by Mr. C. J. Gahan (1891, p. 367), by Mr. H. Donisthorpe (1901, p. 345), and the Presidential Address of Canon W. W. Fowler, Jan. 15, 1902 (Proc. 1901, p. xxxiii). I have also had the opportunity of reading the manuscript of an important paper by Mr. R. Shelford on mimicry in Bornean insects, now being published by the Zoological

Society of London, and of arranging an abstract which is printed in the Report of the British Association at Bradford, 1900, p. 795.

But, above all, I wish to express my thanks to Mr. C. J. Gahan and Mr. G. A. K. Marshall for their kind advice and assistance in the attempt to arrive at sound conclusions.

The groups about which there seems to be no doubt at all—conspicuous, constantly refused by insect-eaters, and liable to be mimicked by other Coleoptera—are the following :—

1. Erotylidæ. Very apt to enter into conspicuous combinations which are doubtless synaposematic with other beetles.

2. Coccinellidæ. Greatly mimicked by other beetles and insects of other orders. Very commonly form synaposematic assemblages (see p. 520).

3. Malacodermidæ, including the *Lycinæ*, *Lampyrinæ*, and *Telephorinæ*. Greatly mimicked by beetles of other families, and also by insects of other Orders (see pp. 515–518).

4. Melyridæ. Some of the species convergent towards *Lycinæ* and *Telephorinæ;* others characterized by the possession of thoracic glands, which are exserted when the insect is irritated.

5. Cantharidæ. Undoubtedly a distasteful group with conspicuous warning coloration. Some of the species are synaposematic with other beetles, and with Aculeate Hymenoptera (see pp. 516–518 and 525–527), while others afford models for mimicry and synaposematic approach (pp. 518, 519).

6. Chrysomelidæ. The sub-families, *Galerucinæ* and *Hispinæ* are especially largely mimicked by other beetles, and fall into synaposematic combinations. The *Chrysomelinæ*, *Eumolpinæ*, etc., also enter into combinations which are doubtless Müllerian (synaposematic). The *Megalopinæ*, however, may be mimetic (pseudaposematic) rather than synaposematic.

Concerning the last-named family, Mr. Gahan writes to me, March 3, 1902 :—

"In reference to my previous paper on *Diabrotica* [Trans. Ent. Soc. Lond., 1891, p. 367], there are a few facts since published in a paper by F. M. Webster 'On the probable origin, development, and diffusion of North American species of *Diabrotica*.'

"'The fact that several species of this genus are literally swarming over large areas of country, and their habits are such as to expose them almost continually during the adult stage to attacks of birds, while in all of the investigations of the food of birds they rarely appear, has raised the question of their being inedible.'

"Webster gives also a quotation from Bates' 'Naturalist on River Amazon,' which I had overlooked:—

"'The Eumolpidæ and Galerucidæ were much more numerous than the Chlamydes and Lamprosomas, although being also leaf-eaters, and having neither the disguised appearance of the one nor the hard integuments of the other; but many of them secrete a foul liquor when handled, which may perhaps serve the same purpose of passive defence.'"

There are two other groups which may eventually be placed beside the six families named above.

Endomychidæ. Mr. Shelford's experiments show that several of the Bornean species are most distasteful. They are abundant and extremely conspicuous; they form synaposematic groups, especially with the *Erotylidæ*, and there is one beautiful example of mimetic resemblance to an Endomychid model by a Bornean Longicorn. The style of colouring in the family suggests that it contains Müllerian groups (see also p. 522).

Pyrochroidæ. The colouring and habits suggest that these Coleoptera are highly distasteful; they may even belong to the first rank in this respect.

We now pass to a Coleopterous family which may with more probability be placed beside the *Hypsidæ* or *Chalcosiinæ*, undoubtedly distasteful groups of moths which nevertheless are exceedingly apt to display Müllerian resemblances to other presumably still more strongly-protected Lepidoptera. In such synaposematic combinations they appear perhaps invariably to take the patterns and colours of others, rather than impress the stamp of their own likeness on the assemblage.

Cleridæ. These beetles are, like the above-named moths, most apt to take on the appearance of still more distasteful allies, such as the *Lycinæ*, the *Cantharidæ*, the *Galerucinæ*, and, in the genus *Allochotes*, the *Coccinellidæ*. They are great mimics of *Mutillidæ*, and less commonly of ants. Mr. Shelford has come across one beautiful example of the mimicry of common Bornean Clerids of the genus

*Lemidia*, by a Longicorn of the genus *Daphisia*. The common mimicry of *Mutillidæ* may be due to an original body-form, size, and colouring, which rendered the resemblance to such models peculiarly easy and rapid of attainment by selective means. *Cleridæ* also occasionally possess warning colours of their own. Examples are found in the genus *Lemidia* mentioned above, and in an abundant, bright-red, strongly-smelling South African species of a genus which is probably new. The latter was rejected by insect-eating animals (see p. 344).

We now come to four groups which the experiments here recorded show to be at any rate partially distasteful. They are often very conspicuous, sometimes from an aposematic colouring peculiar to themselves, sometimes from their sluggish movements and size, and the manner in which they expose themselves or move freely in the open. They are, however, not as a rule mimicked by other beetles, and they do not largely enter into synaposematic association with the most distasteful Coleoptera.

Scarabæidæ. The diurnal South African species are all conspicuous, and freely expose themselves. Their colours, black, green, or coppery, are all conspicuous against the ground on which they are always found. The largest South African species (*Scarabæus femoralis*) adopts a warning attitude when it is disturbed. Many of the species were evidently distasteful to insect-eaters. It is possible that their special defence is due to the nature of their food.

Cetoniidæ. The majority of South African species, including all the larger species, are conspicuous on flowers or exuding gum. They freely take wing in sunshine, but are quite sluggish in cloudy weather. Their colours vary greatly, but very conspicuous and contrasted tints are often present. Many of the species were found to be unpalatable.

Tenebrionidæ. Mostly dull browns and blacks, generally diurnal, terrestrial, and slow-moving. Several species proved to be distasteful.

Lagriidæ. The South African species are often iridescent green or purplish, many brown or black. They are abundant and very sluggish; they freely expose themselves in conspicuous positions on leaves, and have a strong smell. Although but few experiments were made, it is probable that the whole group is distasteful.

The case of the Longicornia is peculiarly interesting.

They may be considered as parallel to the *Nymphalinæ* among Rhopalocera. In both we have a great preponderance of species with cryptic habits and colouring, while genera mimetic of the most distasteful groups of their respective Orders are also common. In some of these examples the mimicry is almost certainly Müllerian, as in the case of *Neptis* and *Limenitis* among the *Nymphalinæ* and *Cymatura* and *Ceroplesis* among Longicorns. Furthermore, the *Clytinæ* and *Callichrominæ* have been shown by Mr. Shelford to be mimicked in Borneo on a large scale by other Longicorns, although the former tend strongly to mimic Aculeates in nearly all parts of the world. Similarly, there is good reason for thinking that the genera *Neptis* and *Limenitis*, which may be mimetic, are also themselves mimicked by other *Nymphalinæ*, etc.

There remain the remarkable cases of the *Cicindelidæ*, *Carabidæ*, and *Curculionidæ*, which are probably without any strict analogy in the Lepidoptera. The two former require special mention, the last-named are treated separately on pp. 522–525.

Cicindelidæ. These Coleoptera supply models for mimicry by a Locustid in Borneo, and Mr. Shelford also considers that one of them is mimicked by a fly. They are also known to be mimicked by Longicorns. Many South African *Cicindelidæ* are convergent towards, or mimetic of, *Carabidæ*, especially those of the latter which are themselves convergent towards *Mutillidæ* (see pp. 511–515). Some of the species have a peculiar scent. On the other hand, their swift movements and retiring habits are inconsistent with a high form of special protection.

Carabidæ. Mimicked in Borneo by a Locustid. Probably more strongly defended by the possession of anal glands than are the *Cicindelidæ*, and in the combinations between the two families it is seen that the latter have approached the former, rather than *vice versâ*. Certain groups of *Carabidæ* form pseud- or synaposematic combinations with the *Galerucinæ* and also with the *Mutillidæ*. The South African smaller and moderate-sized diurnal species have habits very similar to the *Cicindelidæ*, but are not so swift. They commonly possess directive marks indicating the specially-protected anal region. The largest South African species (*Anthia*) have a very large charge of the defensive secretion and extremely powerful mandibles. They freely expose them-

selves, and are most conspicuous, often possessing a highly-characteristic warning pattern. They adopt special warning attitudes, and do not run away when they are attacked (see p. 510).

These two families may be perhaps compared to the powerful group of the hawks, which are mimicked by the feeble cuckoos, and yet, when attacked, are themselves swift in flight, but can render a good account of themselves when active defence becomes necessary.

23. Experimental Evidence of the Value of the Terrifying Markings in *Chœrocampa* Larvæ. (G. A. K. M.)

*Salisbury, April* 16, 1899.—I offered baboons a full-grown larva (about seven inches long) of *Chœrocampa osiris*. The larva is remarkably snake-like, the general colouring somewhat recalling that of the common puff-adder (*Bitis arietans*). The female baboon ran forward expecting a tit-bit, but when she saw what I had brought she flicked it out of my hand on to the ground, at the same time jumping back suspiciously; she then approached it very cautiously, and after peering carefully at it from the distance of about a foot, she withdrew in alarm, being clearly much impressed by the large blue eye-like markings. The male baboon, which has a much more nervous temperament, had meanwhile remained at a distance surveying the proceedings, so I picked up the caterpillar and brought it towards them, but they would not let me approach, and kept running away round and round their pole, so I threw the insect at them. Their fright was ludicrous to see; with loud cries they jumped aside and clambered up the pole as fast as they could go, into their box, where they sat peering over the edge watching the uncanny object below. After a while the female seemed inclined to descend to investigate matters again, but owing to the manner in which they had entangled their ropes she could not descend without the male, and he very emphatically refused to move. On concealing the larva I managed to coax them down again, and then seizing the rope to which the male was tied, I drew him slowly towards me holding up the larva in the other hand; he simply screamed in abject terror, so I let him go, and they retired to their box. The whole performance was a most remarkable demonstration of the high value of the terrifying colours in these larvæ.

. . . Their terror of the insect was most amusing, and was an eloquent testimony to the great value of this form of colouring to so bulky a larva. I do not think any one could now argue that the theory of terrifying coloration is far-fetched, as I have heard contended. The snake-like appearance seems capable of deceiving more intelligent animals than baboons, for it is not long since I received a box containing a mutilated specimen of this caterpillar accompanied by a note inquiring, "Is this a snake?"

[This evidence recently obtained by Mr. Marshall, added to that already published by Professor Weismann, Lady Verney, and the present writer ("Colours of Animals," London, 1890, pp. 260, 261), leaves no doubt that the conspicuous eye-spots of *Chærocampæ* and other large larvæ are really terrifying and do actually alarm their enemies. The results observed are consistent with the production of a feeling of terror rather than of distaste or repugnance such as Portschinski supposes to result from the sight of an ocellated spot. In his remarkable papers on "Coloration marquante et Taches ocellées" (St. Petersburg), this acute and imaginative naturalist states his belief that ocellated spots represent the appearance of a drop of warning liquid. He develops this hypothesis with the greatest ingenuity, and describes and illustrates a large number of such spots in insects of many kinds. In some ocellated spots he sees represented the reflection of the sky in a drop of warning liquid; in others, the distorting effect of gravity upon a drop resting on a vertical surface: in the sounds made by certain irritated Mantides, as they display the spots on their raptorial legs, he believes he hears a representation of the rushing sound of a warning liquid forced through a fine aperture. My kind friend Professor W. R. Morfill has given me the opportunity of learning the remarkable and highly-imaginative views of the distinguished Russian naturalist. On some future occasion I hope to be able to lay them before English-speaking naturalists in much greater detail. For the present I desire to point out that the results obtained by experiment do not support his conclusions, but suggest in the most convincing manner that terror, such as is caused by the appearance of a serpent, is produced by the display of eye-like marks on a large caterpillar. Terror may be similarly caused by the display of large ocellated spots on the wings of imagines, while in other

cases they probably act as directive marks, diverting the attention of an enemy from the body of the insect (see pp. 371–5 and 440–1). To the former category probably belong the remarkable eye-like spots on the tegmina of certain Harpagid Mantides; for Mr. Marshall writes (1902) of a South African species: "The eye-like markings on the wings of the Mantis, *Pseudocreobotra wahlbergi*, are, I think, almost certainly of a terrifying character. When the insect is irritated the wings are raised over its back in such a manner that the tegmina stand side by side, and the markings on them then present a very striking resemblance to the great yellow eyes of a bird of prey, or some feline animal, which might well deter an insectivorous enemy. It is noticeable that the insect is always careful to keep the wings directed towards the point of attack, and this is often done without altering the position of the body."—E. B. P.]

24. Evidence of a Superstitious Dread of the Larva of *Chærocampa elpenor*. (E. B. P.)

Professor Weismann and Lady Verney have shown that the larva of *C. elpenor* terrifies birds, and I have found that *Lacerta viridis* was at first much intimidated, but finally overcame its fright and devoured the larva. An account of these observations is given in "Colours of Animals," Poulton, 1890, pp. 260, 261. I have recently ascertained that the larva is regarded with superstitious fear in certain parts of Ireland. This I owe to the kindness of my friend Mrs. Nuttall, the American anthropologist, who has drawn my attention to an article by Mrs. Frances J. Battersby, of Cromlyn, Westmeath, in "Knowledge," vol. 21, 1898, p. 256, and reprinted in "Public Opinion," Nov. 11, 1898, p. 622. The writer quotes the following quaint and amusing account of the larva, and the sympathetic magic by which its supposed evil influence is cured, from "A Chorographical Description of the County Westmeath," by Sir Henry Piers, of Insternaght (1682): "We have a certain reptile found in our bogs called by the Irish the 'Connagh worm.' This is an ugly worm, sometimes as thick as a man's thumb, about two or three inches long, having, as all reptiles have, many short feet, a large head, great goggle eyes and glaring, between which riseth or jutteth forth one thick bristle, in shape like a horn, which

is prominent and bendeth forward about three-quarters of an inch. Whatever beast happeneth to feed where this venemous worm hath crept (some say if he do but tread there) is certainly poisoned, yet may be infallibly cured if timely remedy be applied; the case is twofold, yet in effect but one, both proceeding from the very worm itself. Some there are that take this worm and, putting it into the hand of a new-born child, close the hand about it, tying it up with the worm closed in it till it be dead. This child ever after, by stroking the beast affected recovers it, and so it will if the water wherein the child washes be sprinkled on the beast. I have known a man that thus would cure his neighbours' cattle though he never saw them. The other method of cure, which I like much better, is by boring an augur-hole in a well-grown willow-tree, and in it imprisoning but not immediately killing the worm, so close by a wooden peg that no air may get in, and therein leaving him to die at leisure. The leaves and tender branches of this tree ever after if bruised in water, and the affected beast therewith be sprinkled, he is cured. The All-wise and Ever-gracious God having thus in His Providence ordered it that not only this venemous reptile, but divers others, and who knows if not all, did we know the right method of using them, should have in themselves their own antidotes, that so we might have a remedy at hand as the poet sayeth :—

'Una eademque manus vulnus opemque ferat.'"

The authoress also shows that a superstitious dread of the larva still persists among the Irish folk. In all the descriptions the terrifying eye-like marks have a prominent place. A "clergyman's daughter, walking near a ditch, 'saw her little dog barking and snapping at a most curious-looking creature with staring goggle eyes.'" One of the country-folk said that the creature "had a round head like a cat's, and goggle eyes." "He was afraid to touch it, as its eyes glared like a frog's, and said it bit or stung cattle, when their heads swelled up; and a man was once bit on the leg, which swelled up, and he nearly died." A labourer, going to fetch a tin basin from a field, "found a Connagh sitting in it, glaring at him." A woman lost one of these caterpillars which she was carrying on a stick, and was reproved by her father "for not having killed the Connagh by smashing it with a stone, 'as now it would sting the cattle.'" The authoress, who is an experienced collector

of Lepidoptera, has also shown specimens of the larva to the country-folk, and ascertained that it was what they call the "Connagh," so that we are not dependent for the identification upon the loose descriptions of ignorant and excited people. She states that there are two models of the "Connagh" in the Dublin Museum "studded with coloured stones, and supposed to have been used as charms." *

Miss Eleanor A. Ormerod in her Eleventh Report, for 1887 (p. 126), also shows that this larva is looked upon "at least in one district in Ireland as the cause of murrain in cattle." Thus "In the course of last year Miss Fleming, writing from Derry Lea, Monasterevan, Co. Kildare, Ireland, mentioned:—'There is a very large caterpillar sometimes found here (I have seen it four inches long), which is said by popular voice to give the disease called "murrain" when licked or swallowed by a cow. The people call this creeping thing a Murrain Worm.'" On Aug. 7, 1887, Miss Fleming sent a specimen which proved to be the larva of *C. elpenor*. Another specimen was sent on Aug. 20, 1887, to Miss Ormerod, by Mr. N. Richardson, from the Estate Office, Castle Comer, Co. Kilkenny.

In the autumn of 1898 (Twenty-second Report, for 1898, p. 72) Miss Ormerod received from Mr. Thomas Wade, of Newcastle-West, Co. Limerick, an account of the disease of a cow which "the farmers, not only here, but all over Munster, seem convinced . . . is caused by 'a worm.'" Although Mr. Wade suggests that they refer to "a lizard, or something akin to it," it is almost certain that we have here another case of the same superstition.

Mr. G. H. Carpenter, B.Sc., F.E.S., of the Science and Art Museum, Dublin, informs me that in 1901 a police-constable in Co. Mayo forwarded a larva of *elpenor* as "a rare kind of reptile," and that a similar description has been given to him by other country correspondents. The evidence of alarm and superstitious dread is however of greater significance than the employment of a word which is so often used inaccurately.

* Mr. Carpenter informs me that the cylindrical form of these models and the large size of the caudal horn on one of them suggest *Acherontia* rather than *Chœrocampa*.

25. Experimental Evidence of Terror caused by the Squeak of *Acherontia atropos*. (G. A. K. M.)

[I had been told by Mr. Roland Trimen that the South African native races commonly have a superstitious dread of this moth, and I was anxious to know whether this was the case in Rhodesia. The observation recorded below indicates very clearly that the sound and the attitude are the cause of the fear; for it was inspired in a native who had never before seen the moth. It is improbable that the moth is distasteful, but its legs are very powerful, and the spines on them sharp enough to cause an unpleasant prick even to human fingers. The behaviour of the *Cercopithecus* is strong evidence that the sound possesses a terrifying significance.—E. B. P.]

*Salisbury, Jan.* 11, 1901.—I was deeply interested in your investigations into the sounds produced by *A. atropos*, but I regret to say that I have never gone into the subject at all. The larva is fairly common with us, feeding on *Solanum* and foxglove, but the imago is not often seen. I showed one to some Mashonas the other day, and asked them if they knew it. "Oh yes!" they said, "it's an 'imvemváne' [a general term for butterflies and moths]; it flies up in the air—whr-r-r-r—and the black man doesn't know how to catch it; only the white man can catch it." When asked if it were noxious, they seemed surprised and said, no, not at all. A Zulu replied in much the same way, and seemed to have no particular ideas about it. Some Zambesis said they did not know it, and when I suggested that it might be a "schelm" [a Dutch word for anything noxious or obnoxious], they said no, and one of them stepped forward and touched it with his finger. But when it arched its back and squeaked loudly, he jumped back in a fright saying: "Oh yes, boss, that's a 'skellem' right enough." I finally gave the insect to my monkey (*Cercopithecus pygerythrus*), making it squeak while doing so. He was evidently struck by the sound, and after watching a few moments grabbed it from my hand, bit off its head, and threw it down violently. He then approached cautiously, and began pulling it to pieces in a nervous spasmodic way, evidently fearing to get stung or bitten every moment; on tasting one of the bits he found it palatable and proceeded to eat it all. I should imagine that the curious movements and squeak of the moth are of a

terrifying character, or it may be really aposematic for certain mammals and birds, to which it may be distasteful. I cannot find from other sources that the Kafirs here have any superstitions with regard to it; the only insects they take any interest in seem to be the various beetles and larvæ which they eat.

### 26. Insect Stridulation as a Warning or Intimidating Character. (G. A. K. M.)

*Salisbury, April* 19, 1901.—I have been thinking of trying to get some material together to support the view that stridulation in insects where occurring in both sexes may be explained in a large number of cases as a warning character, its value in this respect being especially well brought out in a number of obscurely-coloured Heteromera, etc., which are known to be distasteful, while it is largely absent in brightly-coloured, distasteful groups, as *Cetoniidæ, Mylabridæ, Lycidæ*, etc. I should also expect to find it more prevalent among distasteful nocturnal species, where warning colours are of little avail. One of my chief difficulties lies in the larval stridulating organs in Coleoptera referred to by Gahan in his interesting paper (Trans. Ent. Soc. Lond., 1900, p. 433), and I should be much interested if you could kindly tell me whether these larvæ really do stridulate, for I see that Sharp (Camb. Nat. Hist. Ins., Vol. II, p. 198) throws much doubt on the larval stridulation of *Melolonthidæ* and *Scarabæidæ* suggested by Schiödte. *Lucanus cervus* seems to be a well-authenticated case, and it would be most interesting to know whether the larva is distasteful. Darwin's suggestion as to the acquirement of stridulation by one sex and its subsequent transference to the other has always seemed to me unsatisfactory, and its possible warning value occurred to me immediately I began experimenting with Coleoptera. Of course in some cases it might be pseudaposematic, as in Hymenoptera-like Longicorns in which it would suggest the shrill, angry buzz of a wasp. Pocock has already suggested this explanation with reference to scorpions and Mygale spiders, but I am not aware of any one else having referred to it.

[For this interesting investigation a piece of apparatus invented for me by my friend Mr. G. J. Burch, F.R.S., would be extremely useful. It consists of an ordinary double

stethoscope (for both ears) with the usual form of end-piece replaced by a cork traversed by a glass tube about one-eighth of an inch in internal diameter, and with its terminal lip very slightly expanded into a small funnel. If, while the ear-pieces are inserted in both ears, the open end be moved about near to a stridulating insect, an extraordinary reinforcement of sound takes place as the source is approached, so great indeed that I found no difficulty in localizing it within a small area. Excessively minute sounds become clearly audible by the use of this valuable and simple piece of apparatus. If there be good reason to suppose that the stridulation of any insect is inaudible to us, viz. if the structure of its organ and the movements set up as a result of irritation suggest stridulation, it would be feasible, I believe, to transmit the vibrations to some recording surface other than the tympanum of the human ear, and thus to investigate them.

It is usually possible to distinguish readily between the sounds which are emitted in courtship and those which are produced on irritation and are probably of a warning or terrifying significance, inasmuch as they arise from quite different stimuli and tend to be accompanied by characteristic movements or attitudes. This latter association is exhibited by the imago of *Acherontia atropos*, and the snapping sound made by its larva, due to the movements of the mandibles, is also of terrifying significance. I have once heard the epigamic sound of *Halias prasinana*, but only when the male was pursuing the female and the whole mode of flight was subordinated to the ends of courtship. Generally speaking, any sound produced by both sexes on irritation or attack, and accompanied by threatening attitudes or movements (as of the mandibles), or merely violent struggles, is to be interpreted, with a high degree of probability, as a warning or intimidating character. The decision between warning and intimidation can only be arrived at after an experimental investigation into the qualities of each separate species.

Pseudaposematic sounds are also well known in birds, especially those which build in holes in trees and hiss like a snake when disturbed. Many lizards also hiss when extremely irritated. Professor J. W. Gregory, F.R.S., describes a grasshopper at Kurawa which hissed so that he at first mistook it for a snake ("The Great Rift Valley," London, 1896, p. 273).—E. B. P.]

27. Human Experience of the Taste and Smell of Insects affords untrustworthy Evidence of the effect upon the senses of Insectivorous Animals. (E. B. P.)

The idea that human experience would supply a valuable test as to the palatability or unpalatability of insects to their natural foes has occurred to more than one naturalist. In Section 7 of his paper (Mém. de la Soc. Zool. de France, tome vii, 1894, p. 375, § 7), Professor Félix Plateau describes what he calls the "real taste" ("saveur réelle") of the larva, pupa, and imago of *Abraxas grossulariata*: meaning by the words "real taste" the impression produced upon his own palate. After some natural hesitation he tasted a fine lively specimen of the larva, first cutting it transversely into two pieces. After masticating it sufficiently long to be sure of the impression produced, he affirms that it is almost without taste, very slightly sweetish, with nothing whatever unpleasant about it: "ni nauséabonde, ni poivrée, ni acide, ni amère, sans arrière-goût, et j'ajouterai même *agréable*, rappelant un peu celle des amandes douces sèches ou de la noix de coco." The skin is however somewhat tough, which Plateau suggests as a possible reason for the rejection of the larva by certain vertebrate enemies. The pupa was very similar, but even more tasteless than the larva; while the abdomen of the moth produced much the same effect when masticated: "la saveur m'a paru faible, *agréable* et analogue à celle de la chenille."

Plateau considers his experience to be entirely convincing and decisive as to the real taste of the insect to all insectivorous animals. But it is perfectly obvious that the only point which has been proved is that *a single individual of an animal not habitually insectivorous has found this insect to be rather pleasant in taste although decidedly insipid.* But this fact does not enable us to judge in any way of the impressions produced upon the senses of a truly insectivorous animal. That evidence must be judged upon its own merits, and, as Plateau appears to consider that he has shaken it, I give a somewhat detailed account of his treatment of the subject, and especially of his own valuable and interesting experiments, some of which were conducted upon insect-enemies hitherto unobserved and untried from this point of view. In view of the far-reaching character of Plateau's conclusion it becomes necessary to re-examine the

whole of the evidence for the unpalatability of *Abraxas grossulariata*, especially the larva, which has been chiefly employed for the purposes of experiment. Professor Plateau gives a fair and admirable résumé of the work of the earlier experimenters on the larva, showing that they arrived at the opinion that it was unpalatable, from the uniform behaviour of many European insectivorous animals, viz. many species of birds,* two species of spiders, the common frog, the tree frog, and many species of lizards. In describing the last experiments, those of F. E. Beddard, F.R.S., and F. Finn, conducted almost exclusively upon non-European animals ("Animal Coloration," London, 1892, pp. 149, 164, 165), the conclusion is omitted: "these experiments show that, with a few exceptions, the caterpillar of the magpie moth is distasteful to animals." Although a marmoset "ate one up quite greedily," the behaviour of two *Cebus* monkeys and a *Cercopithecus callitrichus*, as described by Mr. Beddard, is most suggestive of the errors likely to arise from a too-exclusive study of insectivorous animals able in confinement to eat but little, or nothing at all, of a food they would obtain in the wild state in plenty and variety. These monkeys "sucked at the caterpillar and threw away the skin after the contents had been entirely extracted; they paused every now and again to sniff suspiciously at the caterpillar, but nevertheless they steadily persevered in munching it." Mr. Beddard's account of the behaviour of non-European birds entirely confirms the conclusions derived from a study of European insect-eaters. It is probably safe to conclude that the species had never seen the larva before, and it is not surprising that many of them should peck at it. But although from Mr. Beddard's statement (*loc. cit.* p. 149) it is clear that over a dozen species were experimented upon, the only bird which certainly swallowed the larva was a large ground cuckoo (*Carpococcyx radiatus*). The author

* I am now glad to be able to add the evidence that a sparrow in the wild state rejected this moth after capturing it. The observation was made by my friend Mr. G. C. Griffiths, F.E.S., of Clifton, Bristol, a naturalist of great experience and powers of observation. Mr. Griffiths writes as follows:—"I was standing on June 30, 1900, among the trees on Clifton Down at mid-day, when a specimen of *A. grossulariata* flew out from a wych-elm and passed slowly across over a gravel path. A sparrow darted after it and bit off all its wings, but held its body scarcely an instant, dropping it upon the path, where I picked it up—a very satisfactory proof of its distastefulness."

is also "inclined to think" that a white-eye (*Zosterops*) ended by swallowing the insect after masticating it for a long time. The behaviour of the cuckoo is really confirmatory of previous observations, for it has been long known that our own cuckoo is a coarse feeder, and there is even evidence that it eats this very species, as pointed out by our President in the Annual Address for the present year (Proc. 1901, p. xli). The experiments made by Beddard and Finn on lizards support previous conclusions: "chewed and refused by *L. viridis*, and disregarded by *Zonurus* and *Amphibolurus;*" but they state that a toad ate the larva. From their other observations on these Amphibia, it appears certain that toads are indifferent to modes of defence which are efficacious against the majority of insect-eaters; but many more observations and experiments under various conditions are needed before we can safely conclude that *Abraxas* is palatable to these enemies. As possessing some bearing on the question, it is to be noted that a toad which had swallowed a caterpillar of *Euchelia jacobææ*, "almost immediately threw it up" (p. 159).

We now come to the more recent experiments of Professor Plateau. He found (§ 5) that eight *Cistudo europæa*, which were certainly insectivorous, inasmuch as they devoured beetles, paid no attention to the larva of *Abraxas*, with the exception of one individual which seized a larva and then abandoned it. *Coluber æsculapii* and an Italian variety of *Lacerta muralis* paid no attention to them, and if, when one of them opened its mouth, a larva was inserted, it was immediately rejected. As regards Amphibia (§ 6), Professor Plateau found that the common frog acted exactly as Dr. A. G. Butler has described. He further believes that the frog never again attacks the caterpillar which it has once seized and rejected, although, as the larva walks off quite uninjured, the frog sometimes follows its movements for a few seconds. He then threw some larvæ into an aquarium containing a number of *Triton punctatus*, many of which seized and "made efforts to swallow them, giving, according to their custom, sharp blows with the head to right and left. But the prey was too big, or the skin too tough, for the Tritons abandoned them after a few minutes." The newt swallows its prey whole, and has great powers of expansion to meet the special difficulty of size, so it is far more probable that these Amphibia were influenced in the same manner as

the frogs and the water tortoises experimented on by Professor Plateau. He then offered the larvæ to the larger *Triton alpestris*, which paid no attention to them.

Professor Plateau's experiments on spiders are described on pp. 325–7, where it will be seen that the larvæ were either neglected or treated as A. G. Butler described by *Amaurobius ferox*, *Tegenaria domestica*, and *Agelena labyrinthica*. The imago on the other hand was constantly eaten by *Tegenaria*, offered once to *Epeira diadema* and eaten with avidity, killed but rejected by *Agelena*.

His experiments on *Carabus auratus* and two species of *Dytiscus* are described on p. 330: they indicate clearly that these predaceous beetles freely attack and devour both larva and imago of *Abraxas*.

The above is a résumé of the evidence as Plateau gives it, although he also includes the attacks of insect-parasites. These I have quoted on p. 338; but the other observations recorded in the same section of this memoir indicate that insects with warning colours and distasteful to the (non-parasitic) enemies of their class are specially liable to these attacks, so that the results obtained by Plateau in this section (§ 10) of his paper tend, so far as they go, to support the conclusions he seeks to destroy.

As regards the vertebrate enemies Plateau has supplied a considerable amount of evidence in support of the conclusions of his predecessors. He shows that certain spiders are probably, and some predaceous beetles almost certainly, enemies of *Abraxas* in one or more stages. These latter facts are most interesting and valuable, but they no more controvert or throw doubt upon the behaviour of the generality of insectivorous vertebrates than the admitted exception of the cuckoo, and the pleasant impression produced upon the Professor himself. All the theory of aposematic colouring requires is that the conspicuous form should be unfit as food for the majority of the enemies of its class; and this has been abundantly proved in the case of *Abraxas*. It is unimportant whether our anthropomorphic terms unpalatability, distastefulness, etc., truly express what an animal feels, if we admit the fact, as we are bound to do after the experiments, that the majority of insect-eaters after trial do not eat the insect, and after one or more trials do not seek to eat it unless driven by starvation. Exactly what impressions they feel we can never know, and it is quite unnecessary for the theory

of warning or aposematic coloration that we should know. The behaviour is sufficient, and affords convincing proof.

Plateau also brings two indirect lines of argument to bear on the question. He points out (§ 3) that the larva is not wholly conspicuous, but requires searching for if it is to be obtained in large numbers. This is due to its habit when young of resting along the serrated edges of leaves, exposing only the reddish lateral band sprinkled with black points. This appearance is at a little distance very like the reddish edges of many leaves. When it is older he observes that it stretches itself longitudinally along the branches in the inner darker part of the bush at no great height above the ground. When the bush is shaken it falls or lets itself down by a thread; and as soon as it reaches the ground rolls in a ring. In this position, which it retains for a long time, it resembles the excrement of a bird. Mr. Beddard too points out (*loc. cit.*, pp. 167, 168) that these larvæ "like other Geometers . . . do not begin to feed until evening. I have a quantity of these caterpillars on some thick-leaved shrubs in my garden; during the daytime none are visible, but in the evening they commence to crawl about quite actively." I have myself often observed the larva moving and freely exposed by day on the sides and tops of hedges, but after the statements of these two naturalists I am quite ready to believe that my observations were exceptional. Indeed on general grounds I must believe that this is so; for it would not be an advantage but a great disadvantage to the *Abraxas* to display its aposematic colouring at too great a distance. It has certain enemies, such as the cuckoo, and it would doubtless be dangerous if these were able to see it upon the bush at a great distance. Its colours would be conspicuous enough to the majority of insect enemies hunting the bush for food; and the *very* rough resemblance to leaf-edges, branches, and birds' excrement would never impose upon the eyes which enable their owners to find abundant food in spite of the extraordinarily close likeness to each one of these objects which is attained by so many of the cryptic species which they hunt.

Plateau's second indirect argument depends on the undoubted fact that the pupa of the *Abraxas* resembles a wasp. This he regards as an example of (Batesian) mimicry, and believes moreover that it has never been pointed out before. This is very far from being the case.

In my paper "The Experimental Proof of the Protective Value of Colour and Markings in Insects in Reference to their Vertebrate Enemies," Proc. Zool. Soc., 1887, p. 191, I published a Table (A) of the various combinations of colours of conspicuous insects. Section III of Table A, on pp. 232, 233, contained the combinations of black and yellow and of yellow and black; under the former was placed the pupa of *Abraxas grossulariata* and several Hymenoptera Aculeata, etc., under the latter the larva of *Euchelia jacobææ* and other species. Another Table (B) grouped conspicuous insects according to their patterns. Section I of Table B, on p. 236, is as follows:—

I.—*Ring Pattern.*

| | | |
|---|---|---|
| Pattern developed on abdominal segments. Developed on whole length of body. | Pupa of *A. grossulariata*. Imago of *Vespa*, *Nomada*, and *Bombus*. Larva of *E. jacobææ*. | Alternating rings of yellow and black. |

The following sentences refer to this very section of Table B:—"There is probably in some cases a certain amount of true mimicry in the acquisition of patterns and colours. Thus it is more than probable (as has been previously suggested by other observers) that the species rendered conspicuous by alternate rings of black and yellow gain great advantages from the justly respected appearance of hornets and wasps. It must not be forgotten, however, that the latter forms also probably gain to some extent by the greater publicity which follows from the resemblance" (pp. 235, 238). Furthermore in 1890 the same conclusions were re-stated in almost the same words, save that the species indicated in Table B, Section I, are here introduced into the text:—"Thus it is more than probable that the species marked by alternate rings of black and yellow (including the chrysalis of the Magpie Moth and the caterpillar of the Cinnabar Moth) gain considerable advantages, etc." ("Colours of Animals," London, p. 186).

It is hardly necessary to point out that the resemblance to a wasp is no evidence of palatability, any more than the resemblance, which is often strongly marked, in the same district between wasps of different genera and between

them and Hymenoptera Aculeata of other sections. The present memoir contains splendid examples of Müllerian or synaposematic associations between inedible forms such as *Lycidæ* and stinging Aculeates (see p. 517), and the resemblance between *Abraxas* and a wasp is probably of the same kind, as I suggested in 1887.

My friend Professor W. M. Wheeler of the University of Texas has also tasted a Syrphid fly, *Spilomyia fusca* (Loew), which mimics *Vespa maculata* as well as a smaller wasp. The fly was "found to have an agreeable flavour, the alimentary tract of the insect being full of honey." Hence in this case Professor Wheeler concludes that the colours of the fly are "associated with the absence of disagreeable smell and taste, as the generally accepted theory of mimicry requires" ("Science," N. S. vol. vi, No. 154, p. 887, Dec. 10, 1897). Still later in "The Century Magazine" for July 1901, p. 378, Professor Wheeler describes another experiment as follows:—"The writer while riding through the deserts of Wyoming some years ago was impressed with the day-flying moths (*Pseudohazis*) flitting leisurely along near the ground or resting fully exposed on the glaucous spikes of the sage-brush. . . . They had black-and-white wings and black-and-orange bodies. So striking was this case of apparent warning colour that the writer after much hesitation decided to ascertain by means of the only available experiment whether the insect really possessed the 'nauseous properties' so generally assumed in such cases by writers on the subject of animal coloration. He dismounted from his horse and proceeded to masticate the body of one of the moths. To his astonishment, the little flavour that it contained was mild and pleasant—one might almost say, nut-like." The writer also records that lizards previously fed on house-flies, and therefore not very hungry, "devoured with evident signs of relish" several of the conspicuous day-flying moths *Alypia octomaculata*. Professor Wheeler concludes "that if every field-entomologist could only bring himself to repeat the writer's experiment on *one* of many cases of 'flaunted nauseousness,' and place his taste-impressions on record, we should in the course of time have a really valuable body of evidence, for we can hardly assume that beasts, birds, and reptiles can find things 'nauseous' which are quite tasteless or even pleasant to the human palate."

I believe, on the contrary, that we are justified in the opinion expressed in the last words quoted from Professor Wheeler, and I have proved that we have very good grounds for maintaining that a conspicuous insect pleasant to the human taste is rejected with probable signs of disapproval by many truly insectivorous animals. The tasting of conspicuously coloured insects by entomologists in general, recommended by Professor Wheeler, would I believe be of very little value or more probably of no value at all as evidence of the likes and dislikes of insect-eating animals. Carefully conducted experiments upon such animals, and still better observation of them and their prey in the field, and the examination of the contents of their digestive canal and the components of their faeces, are the only means by which trustworthy conclusions can be reached. We have to deal with a heterogeneous group of animals, alike in one respect, viz. the specialization of digestive apparatus and sense-organs to an insect diet. It is reasonable to suppose that, whatever we may find in man and other forms not markedly insectivorous, in the members of this particular group there will be a specially acute sensitiveness to qualitative differences amongst the innumerable species from which they select their food. It is probable that especial keenness for certain species indicates a high nutritive value, and that the sense-organs of insectivorous animals enable them to detect and thus to reject species which would have an injurious effect, or at the least would be of comparatively low value as food. There is no reason for the belief that an equal degree of specialization exists in animals which are not insectivorous. Least of all is this likely to be the case in man, with his comparatively minute olfactory lobes, the central organ by which there is appreciation of every kind of flavour as well as every variety of scent.

I have thought it desirable to argue the question at some length, inasmuch as the two distinguished naturalists I have quoted, as well as others, find significance in human experience of the taste of insects. The opposite conclusion has always seemed to me inevitable from the considerations set forth above; but if any doubt remains it must be dispelled by reading the following account of Mr. Marshall's experiments upon himself, and comparing it with those which he conducted upon insect-eating animals of many kinds. It is interesting that he should detect bitterness,

acridity, and a Coccinellid-like smell in certain species, but even in these the human experience is probably very faint compared to that of a truly insectivorous animal. Nor does it by any means follow that a scent which is excessively unpleasant to man indicates unpalatability to all or even the majority of natural foes, as in the obvious case of *Anoplocnemis curvipes*, the evil-smelling Coreid bug eaten greedily by baboons (see p. 382), although rejected after tasting by a kestrel (p. 345). Professor Plateau and Professor Wheeler will probably reconsider the significance of their own sense-impressions when they read below that Mr. Marshall could detect nothing unpleasant in the much-mimicked *Limnas chrysippus*.

"*Estcourt, Oct.* 15, 1896.—I have for some time intended to make experiments on the taste of the Acræas. . . . However, my tasting experiments have not helped me much, for my sense of taste is evidently not as acute as that of birds and lizards. However, I send you the few notes I have made in case they may be of interest or use.

"In *Acræa nohara*, *burtoni*, *cabira*, and *Planema esebria*, I was unable to detect any trace of bitterness or acridity, and they appeared to me quite insipid; indeed, as far as mere taste is concerned, I doubt whether I could distinguish them from *Belenois severina*, though their outer integuments are much tougher. [Mr. Marshall subsequently found that *burtoni* does possess a bitter juice, which exudes freely from the wings when they are cut, especially at the bases.] This alone is sufficient to prove the unreliability of the test, for *cabira* is most certainly an inedible species, even if *esebria* is doubtful. *A. encedon* and its var. *lycia* exude a yellow juice from the thorax which is slightly bitter, but not very markedly so. *Acræa anacreon* and *natalica* both exude juice in the same manner, but it seems distinctly more bitter than that of *encedon*. *A. anemosa* in addition to the bitter juice emits a very strong smell when pinched, being the only *Acræa* in which I have noticed this, though possibly *acara* does the same, as I regard these as the two best-protected members of the genus. *Planema aganice* has no smell, but emits a lot of acrid juice, not only from the thorax, but also from the antennæ and the nervules of the hind-wings. With regard to the juice-exuding species I may note that the bitter taste appears to lie only in the exudation and not to permeate the tissues of the body.

"In the few specimens of *Amauris echeria* that I tried I found that no juice was emitted, but they had a nauseous taste and a strong smell, which reminded me somewhat of that emitted by many *Coccinellidæ*. But it was *L. chrysippus* which showed me the futility of trying to arrive at any definite conclusions from this line of research, for it emits neither juice nor smell, and I could detect no trace of any taste, unpalatable or otherwise, but the tissues have a somewhat soapy feel to the tongue, which I noticed in *A. echeria* and some of the Acræas. The same may be said of *Mylothris agathina*, though from its conspicuous colouring, slow flight, and wide dispersal, I feel sure it is an inedible species.

"*Malvern, Feb.* 21, 1897.—*Acræa horta* exudes a bitter yellow juice from the thorax when it is injured, and this juice permeates the costa of the fore-wing. The head and abdomen do not appear to me to have any unpleasant taste. Trimen refers to their smell, but my smelling powers are not sufficiently acute to detect it.

"*Malvern, May* 14, 1897.—*Alæna amazoula* feigns death most persistently; it has an unpleasant taste and strong smell not unlike that of the *Coccinellidæ*."

## 28. Guy A. K. Marshall's Proof of Seasonal Changes in South African Butterflies of the Genus *Precis*. (E. B. P.)

### A. *Introduction.*

The attempt will be made in the following section of this memoir to explain these astonishing changes as due to the adaptation of a moderately distasteful and protected genus in two directions—towards conspicuous warning colours in the generations of the wet season, the time when insect-food is abundant; towards procryptic concealment in the pressure and scarcity of the dry season.

Facts which require for their interpretation the hypothesis of adaptation in the direction of conspicuousness will be brought forward, much use being made of the conclusive proof only recently obtained by Mr. Marshall, by breeding the one from the other, that *Precis simia* is the wet phase of *P. antilope*.

The distinct habits and stations of the two phases, their relation to other seasonal forms of butterflies, the observed

differences in the insect life of the two seasons, will all be shown to be consistent with the above hypothesis.

The results of Mr. Marshall's experiments as to the nature of the stimulus by which the change is started in any individual will be discussed, and further lines of investigation suggested. The much greater size and weight of the dry phases will be shown to have an important bearing upon the inquiry, indicating, as it does, that the phase must be predetermined in the larval stage.

Finally, it will be argued that the facts proved by Mr. Marshall, although most startling and indeed astounding, are not subversive of any of the principles of the science of systematics.

## B. *Historical.*

In his great work on "South African Butterflies" (London, 1887, vol. i), Mr. Roland Trimen describes several intermediate varieties between *Precis natalensis* and *P. sesamus*, and records Mr. F. N. Streatfeild's capture of the two butterflies *in coitu*. He concludes (*loc. cit.* pp. 231 and 233), "It is only to such occasional unions, and to their fertility, that the origin of the intermediate examples under notice can be attributed."

Mr. Trimen also makes a similar suggestion as to the intermediate varieties between *pelasgis* and *archesia*, which are also recorded as having been taken *in coitu* (*loc. cit.* p. 235).

Mr. Guy A. K. Marshall first published in 1896 the suggestion that a group of South African butterflies described and known as different species of the genus *Precis* or *Junonia* were in reality the seasonal phases of a comparatively limited number of species. He pointed out, however, that *octavia* and *amestris* (*s. l.*) had been previously considered as two forms of a single species by M. Charles Oberthür of Rennes (Ann. Mus. Genov. xviii, 1883, p. 721), and also that Mr. C. N. Barker, the distinguished Natal naturalist, had been long convinced of the existence of these seasonal phases, and especially of the most remarkable case of all, *P. sesamus*, and its wet-season form, *natalensis*.

Mr. Marshall's general description of the differences between the two phases is as follows: "The dry-season form is smaller, and usually assumes a duller type of colouring on the upper-side, sometimes of quite a different hue; the

under-side becomes of a general brownish tint, more or less resembling a withered leaf, the likeness being heightened by an oblique line running from the apex of fore-wing to the anal angle of hind-wing, representing the mid-rib; also by the marked prolongation of the fore-wing, so well known in the winter form of *Melanitis leda*. Lastly, the ocelli on the under-side are much reduced or obsolescent" (Trans. Ent. Soc. Lond., 1896, p. 557). I am unable to understand the opening statement that "the dry-season form is smaller," indeed, Mr. Marshall criticizes a more general statement of the same kind made by Mr. C. N. Barker (*loc. cit.* p. 551). In the very first species described from this point of view by Mr. Marshall, *Precis tugela*, he speaks of "the smaller summer form," and the only other *Precis* in which he speaks of a difference in size is *P. artaxia*, of which he uses almost the same words (p. 561). I have since compared the two phases of the following species in the Hope Collection, with results shown below:—

*Precis tugela*, dry phase larger.
„ *ceryne*, „ „ much larger.
„ *actia*, „ „ „ „
„ *pelasgis*, „ „ rather „
„ *sesamus*, „ „ distinctly larger.*
„ *antilope*, „ „ much „
„ *artaxia*, „ „ „ „

See also pages 451 and 456 for the proof by weighing of the great difference between some of these phases.

Since the above paragraph was written Mr. Marshall has informed me that the statement was certainly a slip of the pen, which remained uncorrected, because he was unfortunately unable to see the proofs of his paper.

Although Mr. Marshall anticipated the results of future discovery in a truly remarkable manner in this memoir (Trans. Ent. Soc. Lond., 1896, p. 557), and brought forward evidence of a most convincing kind, yet the conclusion which required to be proved was to most naturalists so highly improbable, because of the extraordinary differences between the supposed species, that nothing less than the actual breeding of one form from another was sufficient.

In his second paper on the subject (Ann. and Mag. Nat.

* Difference much less marked in specimens from northern part of range.

Hist., ser. 7, vol. ii, July 1898, p. 30), which it is only just to describe as epoch-making in the history of seasonal dimorphism, Mr. Marshall recorded this great discovery, and published the fact that he had succeeded in breeding *sesamus* from *natalensis* in three cases. The specimens themselves Mr. Marshall presented in two cases to the Hope Collection at Oxford, in the third to the British Museum of Natural History. The Oxford specimens are figured on Plate XII, figs. 1 and 2 the parents, figs. 1*a*, 1*b*, and 2*a* the offspring. The dates of the various stages are given in the description of the plate.

These specimens must always have historic interest, and I have therefore published in the plates accompanying this memoir a representation of the whole of the evidence obtained by Mr. Marshall in 1898, so far as it is at my disposal. The extracts from Mr. Marshall's letters bearing on the same subject have also historic interest, and are therefore recorded in full below.

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—I am sorry to say I have never yet bred *natalensis* through to *sesamus*. At Karkloof, Natal, I managed to secure three eggs in March (just the right month for the purpose of testing the hypothesis that they are the same species), and one of the resulting larvæ was fully half-grown when I left there for Malvern, near Durban. I brought them down with me, as I knew that C. N. Barker had bred *natalensis* from the larva, and so would know their local food-plant. The Karkloof plant does not occur at Malvern, and the larvæ utterly refused the Malvern food-plant and everything else I tried them with; so they pined away and died.

"I have not the least doubt of the specific identity of these two forms; they are undoubtedly confined respectively to the wet and dry seasons, they have been frequently observed *in coitu*, and intermediate forms occur at the change of seasons. The larvæ are identical and feed on the same plant; for out of twelve larvæ taken by Hutchinson off one plant, ten were *natalensis* and two *sesamus*. I always think *natalensis* is an interesting species as showing the brilliant colours which can be acquired by an unprotected species without detriment. A newly-emerged *natalensis* is a glorious insect, and rivals the brightest Acræas in its colouring on both surfaces; moreover, it is a frequenter of open country, where its salmon-red wings

are a conspicuous object as it sits sunning itself on plants or stones. But it is very wary and difficult of approach, being kept on the alert by its enemies, the lizards. I have often watched these little reptiles stalking both *natalensis* and *pelasgis* round the stones, and have seen them capture and eat both species."

"*Salisbury, March* 6, 1898.—You will be pleased to learn that within another few weeks I hope to have been able to have solved the *natalensis-sesamus* question. Three weeks ago I obtained five eggs from a female of typical *natalensis;* two proved infertile, one young larva I lost, but the remaining two are thriving and growing splendidly. Later on I got three more eggs, which have hatched successfully. To-day I took one more, and also, which pleased me much, an egg of typical *Precis simia*, which I am convinced is the wet-season form of *P. cuama* (Hew.), in spite of Butler's remarks. The *natalensis* question I am all the more anxious to settle, as I have now strong collector's evidence against me, viz. Distant, who records that he only took one *natalensis* at Pretoria, whereas *sesamus* was abundant and occurred all through the wet season."

"*Salisbury, June* 5, 1898.—You will be glad to learn that I have at last proved the identity of *P. sesamus* and *natalensis* by breeding the former from eggs laid by the latter in three instances, and I send you the parent and offspring in two of the cases, the third I am sending to the British Museum. You may imagine my delight on seeing the first specimen emerge, for though I felt convinced that the result would be as I anticipated, yet Distant's remarks raised a haunting fear that perhaps I had made a big mistake after all. However, I am glad to say this was not so."

### C. *The Demonstration by* Guy A. K. Marshall *that* Precis simia *is the Wet Phase of* P. antilope.

Only a few weeks ago Mr. Marshall obtained this further proof of the soundness of the conclusions he reached, and the validity of the evidence he adduced in 1896. A female specimen of *P. simia* was tracked while she laid nine eggs, on Feb. 23, 1902, at Salisbury. The butterfly was then captured, and is represented on Plate XII, fig. 3, and the under-side on Plate XIII, fig. 4. Offspring of

the form *antilope* were successfully reared from two of these eggs. In the case of the first, shown on Plate XII, fig. 3*a* (under-side on Plate XIII, fig. 4*a*), the egg hatched on March 1, the larva pupated on April 10, and the imago, a female, emerged on April 27. In the case of the second, shown on Plate XII, fig. 3*b* (under-side on Plate XIII, fig. 4*b*), the egg hatched on March 1, the larva pupated on April 14, and the imago, a male, emerged on April 29. All three specimens have been presented by Mr. Marshall to the Hope Collection at Oxford. The great difference between the under-sides of the two offspring (compare Fig. 4*a* with 4*b* on Plate XIII) is deeply interesting. Although so widely different, both equally resemble dead leaves, recalling the various distinct forms of dead leaf represented by the under-sides of the individuals of the same species of *Kallima*. The difference between the outline of the wings in parent and offspring is seen to be far greater in this species than in *sesamus* and *natalensis*, and *archesia* and *pelasgis*, as will be at once seen when the figures on Plate XII or Plate XIII are compared.

Mr. Marshall's account of his success in obtaining the material by which he proved the identity of *antilope* and *simia*, was received in the following paragraph of one of his letters.

"*Salisbury, Feb.* 26, 1902.—I cannot even now agree with Butler's arrangement of *Precis antilope* and *cuama*. For although their extreme forms appear to be very distinct, yet all the chief distinctive characters are unstable and tend to converge. Aurivillius agrees with me in regarding them as conspecific, though he separates *trimeni* and *simia*. A pair of these latter I took *in copulâ* last season, which is sufficient evidence as to their identity in my mind, for I am very sceptical as to interbreeding in a case such as this. However, I have determined to solve the problem this season, and since my return most of my time out-of-doors has been spent in trying to secure authenticated eggs of either summer form. Last Sunday I succeeded at last! I got nine eggs from a single *simia*, and they will probably hatch to-morrow; I hope I shall succeed in pulling most of them through. All my larvæ died in the first stage last year, for owing to the erratic way in which the females lay I could not ascertain the true food-plant, but I think I have it all right this time. I expect to breed both

*antilope* and *cuama* from these eggs, as these forms are just beginning to appear."

As explained above, both pupæ emerged as *antilope*.*

D. *The Habits of the two Seasonal Phases of the South African Species of the Genus* Precis, *and the Stations which they respectively occupy.*

That these butterflies should exhibit a marked difference in habit and station corresponding to a difference in appearance at the wet, as compared with the dry season, is of such paramount importance in the consideration of the significance of these phenomena, that I quote at length all available observations of naturalists—some of them made before there was any suspicion that such forms as *sesamus* and *natalensis* were the two phases of a single species.

In "South African Butterflies," vol. i, London, 1887, p. 230, Mr. Roland Trimen, F.R.S., speaks of the habits of *Precis octavia* [*natalensis*, ⊕ wet phase], as he had seen it "widely spread over Natal in the summer of 1867. It frequents open, grassy hills, especially their summit ridges or highest points, and is very conspicuous, whether flying or settled."

Of the habits of *P. sesamus* ⊙ he writes (p. 233): "Though constantly to be seen flitting about with its congeners, *octavia*, *archesia*, and *pelasgis*, I have noticed that *sesamus* has a greater liking than any of them for shady places, preferring to settle under a bank or in some deep road-cutting. . . . The very dark bronzy-green under-side is well adapted for concealment in such spots."

Of *Precis archesia* (dry), he notes that it "delights to bask or repose on rocks or large stones. Colonel Bowker has noted that it sometimes congregates under rocks, and is often met with in small rocky caverns in deep forest kloofs." Mr. Trimen has noticed at Highlands, near Grahamstown, "a habit in the ♀ *pelasgis* [wet] which I have never witnessed in the case of *archesia* [dry], viz. that of perching himself on the projecting twig of some

* ["Although I am still of opinion that Dr. Butler is in error in regarding *antilope* and *cuama* as distinct species, yet it may be pointed out that the results of this experiment do not in any way disprove his contentions."—G. A. K. M.]

high bush at the edge of a wood, and thence giving chase to other passing butterflies" (p. 237).

In suggesting the seasonal relationships in the genus *Precis* which he afterwards proved to exist, Mr. Marshall speaks at the beginning of his first paper on the subject (Trans. Ent. Soc. Lond., 1896, p. 557) of the special interest which attaches to the alternations in this genus, "not only on account of the great differences in the colouring of their two forms, but also because of their marked change in habits."

He points out that the species of *Precis* in which there is but little seasonal change (*P. tugela*, *P. olgiva*, and *P. natalica*) are, when at rest, leaf-like in both phases, although they are more leaf-like in the dry season. He states that they are furthermore especially forest insects, being confined to "the warmer, low-lying, or heavily-timbered districts." The other species of *Precis* in which the seasonal forms are very different "occur more abundantly, or even exclusively, in the uplands and in open country." There are, however, differences of habit in the species of the former group. Thus Mr. J. M. Hutchinson is quoted by Mr. Marshall as stating that the summer form of *P. tugela* "is a bolder insect, sailing around and settling on trees at a fair height, almost after the manner of *Charaxes*, whereas the other is much more retiring, keeping among the thick bush and settling low down, or on the ground among dead leaves, etc." (*loc. cit.*, p. 558).

Turning to the second group of species in which the seasonal changes are pronounced, Mr. Marshall describes the habits of *P. simia* [*antilope*] (*loc. cit.*, p. 560): "The dry-season form only frequents the bush, settling on the ground among the dead leaves, or very rarely on small plants, the under-side colouring affording it excellent protection. As the season advances the habits of the insect change, and in October and November the later form (*c*) may be found in company with the early form of *simia* (*b*), frequenting open tops of kopjes, flying boldly about within a limited area, and settling with expanded wings on shrubs and bushes. This is the habit of all summer forms of *Precis*. . . ." With regard to *P. sesamus* ⊙, Mr. Marshall remarks that it "differs from the normal type of winter *Precis* in the absence of leaf-like colouring below, and in the very slight falcation of fore-wings. This

is accounted for by its different habits, for instead of frequenting dead leaves in the bush it prefers the dark rocks on stony and wooded kopjes." Evidence is brought forward to show that *P. artaxia* only exists in the cryptic dry phase in the warm timbered coast belt, although it develops a much less well-concealed wet-season phase (*nachtigalii*) in open country (pp. 561, 562).

In his second paper on the subject (Ann. and Mag. Nat. Hist., ser. 7, vol. ii, July 1898, p. 30) Mr. Marshall gives a further account of these interesting differences in habits: "Speaking broadly, the *natalensis* form frequents the highest points in any neighbourhood, especially if they be more or less open (for it is anything but a sylvan insect); whereas the *sesamus* form is more partial to shady spots, and is to be found in ravines and spruits or rocky wooded slopes, and shares with the Hesperid *Sarangesa dimidiata* a marked affection for disused mine-shafts and cuttings. This distinction must not be taken too strictly, for true *sesamus* is occasionally found in company with the summer form on open hill-tops, but principally at the change of seasons; but *natalensis*, so far as my experience goes, is never to be found in the more shady stations frequented by *sesamus*. The latter, moreover, is distinctly warier and more difficult of approach when not feeding, and if alarmed flies off with a rapid, and often zigzag, flight, settling abruptly among rocks or herbage, when its greenish-black under-side colouring is equally protective. *Sesamus* is more often observed in gardens, and not unfrequently enters human habitations in search of a shady resting-place." Mr. Marshall also quotes Mr. J. M. Hutchinson's experience on his farm in Natal, lying in an open plain between two ranges of hills: "He has found *sesamus* resident on the farm, occurring fairly commonly along the banks of the spruits during the winter, whereas *natalensis* is very much scarcer and non-resident, the examples seen having always been travelling from one range of hills to the other, on both of which it is common."

Since his return to England, in the present summer, Mr. Marshall has summarized his experience of the habits and stations of the seasonal phases of the species under discussion as follows:—

"There are three types of stations in South Africa which may be occupied by butterflies of this genus.

1. *Forest country*, with heavy timber affording deep

shade. Found on the coast belt and also in the interior, but, south of the Zambesi, only in patches.

II. *Woodland country*, without timber. Trees small, affording light shade.

III. *Open country*, without trees. Nothing higher than small scrub.

I. The following species are only found in the forest:—

1. *P. tugela.* It has been already explained that the wet-season form exposes itself more freely (p. 421). Both phases have leaf-like under-sides, but the dry has a more hooked tip to fore-wing and more prolonged anal angle to hind-wing.
2. *P. elgiva.* No difference in habits observed. The slight differences in appearance are due to a more hooked tip with a somewhat different direction, and a more leaf-like under-side in the dry phase as compared with the wet.
3. *P. natalica.* No difference in habits observed, both phases being low settlers. Ocelli and white spots on the under-side tend to disappear in the dry phase.

II. The following species are found in the woodland country:—

1, and 2, *P. antilope* and *P. actia.* In both these species the dry-season phase and the female of the wet are found in the more shady places, viz. the lower slopes of kopjes. The ♂ of the wet phase is usually found on the less-wooded higher slopes.

3. *P. artaxia.* The habits are like those of the two preceding species. Towards the forest belt in Umtali the dry phase encroaches on the wet, and in the low country between Umtali and the sea Selous never saw the wet form at all. The larger dry form has a *far* more leaf-like under-side, with a mid-rib, and hooked tip to the fore-wing, wanting in the wet. The dry phase is also more wary.

II. and III. The following species are found in open as well as woodland country:—

1, and 2, *P. sesamus* and *P. archesia* have very similar habits. The dry phase generally frequents the wooded and the wet phase the open country. In entirely open country the former would occur on the lower slopes in whatever shade is to be found. In entirely woodland country the dry phase would be found on

the lower, more shady slopes, the wet on the upper slopes where there is less shade.

III. The following species only occurs (in Mashonaland) in open country:—

1. *P. ceryne*. Both forms are found in open swampy districts, without bush. Rare."

E. *Evidence of Adaptation in the conspicuous under-sides of the Wet-Season Phases almost equal to the proof of it in the cryptic Dry Phases.*

The evidence of adaptation in the cryptic under-sides of the dry phase in the species under discussion is so clear and so generally admitted that it is unnecessary to say much about it. I will only point to the manner in which the various distinctive elements of this phase are co-ordinated to a common end, that of concealment. Thus in the dead-leaf-like forms such as *archesia* and *antilope* we find the prolonged anal angle of the hind-wing, the produced and bent apex of the fore-wing, the angulated outline between these points, the stripe representing a mid-rib, the colours and patterns varying in different individuals but always resembling some type of dead leaf with discoloured blotches or eaten into holes (*archesia*). Most important of all there is the co-ordination of all these diverse elements with appropriate habits and the choice of an appropriate station. In *archesia*, which commonly frequents rocks, the intensely variable mottled appearance produces a strongly cryptic effect at a little distance, while a close inspection only brings out the details which produce a graphic representation of a dead leaf. In *sesamus* the outline and under-side differ from those of the dead-leaf-like dry phases of the other species, and differ in a direction which is specially cryptic, because of the peculiar habits of this phase of the species (see pp. 420, 422).

All this will be at once admitted by every naturalist who studies the specimens, as it is proclaimed by all who have had the advantage of observing the species in the wild state. What is not admitted, but is I think almost equally clear, is the fact *that adaptation in the opposite direction, viz. the direction of conspicuousness, is characteristic of the under-sides of the wet phase.* If the under-side merely reproduced the conspicuous pattern of the upper-

side of the wet phase the case would be strong and convincing for adaptation, and an interpretation based on the principles of warning colours or mimicry, Batesian or Müllerian. But the under-side does more than this; it differs from the upper-side, and so far as it differs, it becomes *more conspicuous*. The following details render the case for adaptation in the direction of conspicuousness, as it seems to me, overwhelming.

In comparing the upper- and under-side of the wet phase of the species to which the chief attention of naturalists has been directed, it is of special interest to turn to the accurate descriptions of Mr. Roland Trimen, F.R.S., written long before Mr. Marshall's discovery was thought of, a time when *natalensis* and *sesamus* were not only considered distinct but were even separated by *eryne*. In "*Rhopalocera Africæ Australis*" (London, 1862–66) we read, on pages 130, 131, of *Junonia octavia* [*Precis sesamus*⊕]: "UNDER-SIDE.—*Much paler, more creamy in tint, with a glistening pinkish tinge.*" Again, on the under-side of the fore-wing the author speaks of "the row of spots parallel to hind-margin commencing distinctly *from costa*, the first two spots increasing the number to seven; double row of bluish lunules more conspicuous than on *upper-side*, whiter." And the under-side of the hind-wing is thus described: "Basal black *containing four rather large, very conspicuous spots of the ground-colour*, and dusted with blue scales, which form a transverse streak between costal and subcostal nervures near extremity of black; whitish-bluish lunules, in hind marginal border, large and very conspicuous." The fact that the ground-colour of the under-side is much paler than the salmon-red of the upper and thus affords a far more effective contrast with the black markings is seen when Fig. 1 on Plate XIII is compared with Fig. 1*b* on Plate XII. Figs. 1 and 2 on Plate XII represent worn specimens, and the comparison with them is invalid. Fig 1*b*, Plate XII, possesses unusually heavy black markings, but the representation of the depth of the red ground-colour is normal for a fresh individual, as is that of the under-side in Fig. 1, Plate XIII. The more complete row of black spots and the greater conspicuousness of the border, owing to the larger white and blue markings in it, as described by Trimen, are also well seen when the figures are compared, but allowance must be

made for the fact that the border represented in Fig. 1*b*, Plate XII, is exceptionally broad, and is still more exceptional, indeed transitional towards *sesamus*, in the size of the blue markings in it. But the lighter character of the markings and the more conspicuous appearance of the under-side border is perfectly clear in Fig. 1, Plate XIII. And there is one other point not expressly mentioned although probably implied by Mr. Trimen, which is I think the most convincing evidence of all in favour of adaptation in the direction of conspicuousness;—the fact that the spots of ground-colour included in the basal black patch of the hind-wing, and absent from the upper-side, are distinctly lighter in tint than the rest of the ground-colour, and *thus afford a far more effective contrast with the black*. This difference in tint is well seen in Fig. 1, Plate XIII. The spot in the basal black of the fore-wing which represents a similarly-placed spot on the upper-side, is also often lighter than the rest of the under-side ground-colour, but the difference is far less marked than in the hind-wing and is sometimes absent.

Now the basal area of the under-side of butterflies' wings and especially of the exposed hind-wing is a part specially seized upon by natural selection for the display of conspicuous warning characters. It is seen in the red patches of many Pierine genera, especially the distasteful *Delias* (appearing also in its Chalcosid mimics) in the Old World, and several *Pierinæ* in the New, where Dr. F. A. Dixey has shown that the character has probably been adopted by *Heliconiinæ* in Müllerian association with them, the relationship—an important discovery first made in 1894 by Dixey—being one of "reciprocal assimilation" or "diaposematic resemblance" (Trans. Ent. Soc. Lond., 1894, pp. 296–298; 1896, pp. 72–74; 1897, pp. 326, 327, 331; Proc. Ent. Soc., 1897, p. xxix). A stripe of bright yellow or red bordering the basal part of the costal margin of the under-side of the hind-wing of a large number of distasteful tropical American butterflies of different sub-families is another very characteristic synaposeme, rendering the same part of the wing especially conspicuous. And in Africa itself we have the most remarkable case of all, in the triangular golden-brown, black-marked synaposeme which is discussed at some length on pages 488 to 490 of the present memoir. Furthermore, there is the group

of large black spots on a light ground which renders this part of the wing prominent in such large numbers of Ethiopian butterflies.

In the wet phase of *Precis sesamus* this area is also remarkably conspicuous, but by a method which is as positive to negative in relation to other distasteful butterflies inhabiting the same part of the world, viz. by the appearance of light spots on a black ground, instead of black spots on a light ground.

Thus it is improbable that this particular element in the conspicuous appearance of the under-side of the wet phase of *P. sesamus* can be mimetic, and its existence, side by side with a general resemblance in colour and pattern to a large *Acræa*, is evidence that such resemblance is Müllerian or synaposematic rather than Batesian or pseudaposematic. This argument is much strengthened by the discussion of the wet phase of the allied *P. archesia* (see pp. 428–430).

Much that has been said of *P. sesamus* applies with greater force to the closely-allied *P. antilope*. On comparing the under-side of the wet phase, shown in Fig. 4, Plate XIII, with the upper-side of the same specimen, shown in Fig. 3, Plate XII, it is at once seen that the difference in tint of the ground-colour and in conspicuousness of the marginal band on the two wing surfaces is far more pronounced than in the species which has been just described. In fact, with an upper-side which is much less conspicuous than *sesamus* ⊕ (compare Figs. 3 and 1*b*, Plate XII: it must be remembered that the ground-colour of 3 is merely tawny, while that of 1*b* is salmon-red), the wet phase of *antilope* combines an under-side which is distinctly more conspicuous than that of the corresponding form of the allied larger species (compare Figs. 4 and 1, Plate XIII). The increased conspicuousness is especially clear in the relative size of the spots in the basal black patch and the inclusion in it of a very large piece of the ground-colour of the fore-wing. Here too the increased lightness of the spots of ground-colour in the black area is often distinct, as it is in Fig. 4, Plate XIII, but in a large proportion of the individuals I have had the opportunity of examining it is only feebly marked.

In *P. antilope* ⊕ there is probably some considerable synaposematic approach towards the *Acræa* type, but to a less extent than in *P. sesamus;* while the conspicuous basal

character which is non-acraeiform and purely aposematic is far more emphasized than in the latter species. It is probable that *sesamus* represents a later development, and that in it the synaposematic elements have been gradually strengthened and the peculiar aposematic character correspondingly reduced.

We now pass to the consideration of a species in which the conspicuous characters of the under-side of the wet phase are probably entirely peculiar and aposematic.

Mr. Marshall's suggestion in 1896 that *Precis pelasgis* is the wet phase of *P. archesia* has never been confirmed by breeding the one form from the other. It is, however, certain that his conclusion was sound. The two forms have often been captured *in coitu*. The female *pelasgis* represented in Plate XII, fig. 4, was captured by Mr. Marshall *in coitu* with the male *archesia* shown in Fig. 5 of the same plate. Intermediate forms are much commoner than in the case of *sesamus* and *antilope;* and above all the relationship of wet phase to dry is far closer in *archesia*, so that it is possible to see how the one was derived from the other more fully than in any of the species with markedly-different seasonal forms. The under-side of one of the commonest forms of the dry phase is represented in Fig. 6, Plate XIII, and opposite to it that of the typical wet phase in Fig. 5. At first sight they appear totally different, and certainly the latter is as conspicuous as the former is well concealed. An uncoloured illustration cannot do justice to the varied shades of brown and grey on the under-side of *archesia* (Fig. 6), and a long series of specimens would be required to show the immense range of individual variation by which all kinds of common appearances presented by dead leaves are reproduced. Among such variations is one in which the dark-brown ground-colour is almost uniform and unmottled inside the mid-rib-like stripe (Fig. 7). From this we pass to forms in which the stripe widens into a light band (Fig. 8), clearly showing its homology with the still more conspicuous band of *pelasgis* (compare Figs. 5 and 8). Such a variety as that shown in Fig. 8 is still a long way on the *archesia* side of a form intermediate between the wet and dry phase, and would certainly be cryptic rather than conspicuous in nature, although not so well concealed as the form shown in Fig. 7, and still less so than that shown in Fig. 6. Truly intermediate varieties between the wet and dry phases are not uncommon, in which

the broad band becomes sharply defined on its outer border, but lacks the light tint of the full wet phase.

These considerations and the careful comparison of Figs. 5 to 8 on Plate XIII will show the essential nature of the changes by which the cryptic under-side of the dry phase is converted into the startlingly conspicuous under-side of the wet phase, or *vice versâ*. The mid-rib-like stripe widens, lightens in tint, becomes sharply defined along its outer border, and is now the "warning band" of *pelasgis*. The row of ocellated spots, many of which, with semi-transparent white centres and specially-coloured borders, suggest holes in the apparent leaf of *archesia*, become entirely or almost entirely black upon the hind-wing, and gain intensely black borders upon the fore-wing of *pelasgis*, and, placed upon the light ground of the "warning band," render this feature still more conspicuous. The mottling disappears, and the ground-colour, both within and without the borders of the "warning band," becomes an almost uniform very dark brown, forming a most effective contrast with the band. Finally, the dead-leaf-like margin of the wing of *archesia* is rendered conspicuous in *pelasgis* by a black-and-white fringe and two parallel series of light markings just within and parallel to the much less deeply indented outline.

Furthermore, the comparison of Figs. 6 to 8 on Plate XIII with Fig. 5 on Plate XII shows clearly enough that the under-side of the dry phase of *archesia* differs from its upper-side in being cryptic, while the comparison of Fig. 5 on Plate XIII with Fig. 4 on Plate XII shows that the under-side differs from the upper-side of the wet phase (*pelasgis*) in being more conspicuous, thus in both respects acting like the two phases of *sesamus* and *antilope*. The under-side of *pelasgis* is more conspicuous than its upper-side because of the increased lightness and greater sharpness of the borders of the band and the greater contrast afforded by a darker ground-colour, also because of the more pronounced light marginal markings.

I have described the relationship between the phases of *archesia* at some length, because it was the consideration of this species which first convinced me of the validity of the interpretation here set forth, that we have convincing evidence of natural selection acting in two opposite directions in the two phases—in the one to produce the maximum of concealment, in the other a very efficient form of

conspicuousness. When I realized that it was the mid-rib-like stripe—the character which more than any other gives meaning to the cryptic resemblance to a dead leaf; that it was this very character which, transformed into the "warning band," became the conspicuous feature of the wet phase—the operation of natural selection seemed as clear in the one case as the other.

When we examine the species of the whole genus *Precis* and those of the genera allied to it, the conclusion is forced upon us that the dry cryptic phases are ancestral as compared with the conspicuous wet phases. I do not mean to imply that the cryptic forms have not altered, but that the original form of the species possessed a cryptic under-side, which has been handed down with more or less change as the cryptic under-side of the existing dry phase, while the conspicuous under-side of the existing wet phase is a new and comparatively recent development. This question of the relative age of the two forms is most important and interesting, and from the very first occupied Mr. Marshall's attention. Thus the following passage is extracted from a letter written a few weeks after his discovery:—

"*Salisbury, June* 5, 1898.—I should be most interested to learn your ideas as to the reasons for the singular seasonal change in this species, for I must admit that I cannot arrive at any really satisfactory conclusion on the subject as yet. The blue scales of *sesamus* are my chief stumbling-block, for I certainly cannot perceive what utility they can possess, and considering its protective under-side colouring there seems no reason why it should not have retained its wet-season colours above, as in the case of *P. artaxia* or *P. cerync*. I suppose you will agree that *sesamus* is a later development?"

For the reasons I have indicated above it is difficult to doubt that the cryptic character of the under-side of *sesamus* is ancestral and the conspicuous under-side of *natalensis* relatively recent, but with regard to the upper-sides this conclusion is by no means so evident. Indeed on comparing the species with *antilope* and other allies, it seems probable that the upper-side of *natalensis* is more ancestral than that of *sesamus*, having been chiefly modified in tint, thus falling into Müllerian association with the larger Acræas. The upper-side of *sesamus* probably shows cryptic changes in the acquisition of the far darker

colours which render the phase less conspicuous in the stations it frequents.

There does not seem to be any escape however from the conclusion that the conspicuous under-sides of the wet phases are relatively recent, and if this conclusion be considered in relation to the comparison between the under-sides of *archesia* and *pelasgis*, it leads inevitably to the conclusion that the *conspicuous* appearance of the one *has* been modified out of the older cryptic appearance of the other, and not *vice versâ*.

On what hypothesis can we believe that such a change has taken place? In the existing state of our knowledge there are only two possible interpretations: (1) that the modification is mimetic of some other conspicuous distasteful form; (2) that it is a warning of some special protection possessed by the *Precis* itself. The former interpretation cannot apply to the case of *pelasgis*, because its pattern is so unlike that of the well-known distasteful Ethiopian Rhopalocera, although some advantage may be gained by Müllerian association with black and white aposematic genera such as *Amauris, Neptis, Planema*, etc. Furthermore, it has been shown that there are important elements in the conspicuous under-sides of the wet phases of *sesamus* and *antilope* which are not synaposematic, although the appearance as a whole is probably to be explained in this way. I therefore firmly believe that the conspicuous appearance of *pelasgis* has been produced by selection from the cryptic *archesia* as a warning character indicative of some special protection, an aposeme proclaiming that it is less palatable or in some way less suitable as the food of insect-eating animals than an immense number of other species which abound during the wet season in the same stations.

I proved in 1887 (Proc. Zool. Soc., p. 191) that the likes and dislikes of insect-eating animals are purely relative, and that a conspicuous distasteful form will be freely eaten under the stress of hunger, that the existence of these forms depended entirely upon the co-existence in their neighbourhood of an abundance of palatable species, that under any other circumstances the warning colours if freely exposed would be a danger and would lead to the extermination of the species. As soon as I had studied the case of *archesia* and *pelasgis* I felt convinced that the

extraordinary seasonal phases of *Precis* were to be interpreted along the lines suggested in 1887—that we have to do with a set of somewhat distasteful species which can only exist in the keen struggle of the dry African winter when food palatable to insect-eaters is relatively scarce, by a very high standard of protective disguise associated with the appropriate instincts, but gain the recognized advantages of aposematic colouring by producing markedly conspicuous generations during the moist summer, when insect-eating animals have a much greater variety and abundance of suitable food.

F. *The severity of the Struggle for Existence among Insects in the African Dry Season as compared with the Wet. The relation of the Seasonal Changes in* Precis *to those of other Butterflies.*

As soon as the idea expressed in the concluding paragraph of the last section of this memoir occurred to me, I wrote to Mr. Marshall asking for his experience on the subject, and also inquiring whether any of the admittedly unpalatable African butterflies exhibited seasonal changes, such that the winter generations became comparatively inconspicuous.

His deeply-interesting reply is printed *in extenso* below.

"*Salisbury, Jan.* 8, 1899.—As to your query about the keenness of the struggle for existence at the two seasons, in my own mind I had never felt any doubt that the dry season is certainly the more critical period for insects, and this I referred to incidentally in my paper on *Precis* (Ann. and Mag. Nat. Hist., ser. 7, vol. ii, July 1898, p. 36). It is true that insectivorous birds are far more numerous during the summer, but this I think would be more than outbalanced by the increase of such insects as Coleoptera, Hymenoptera, Diptera, etc., apart from the fact that the summer broods of the perennial butterflies are undoubtedly larger and much more numerous (some *Pierinæ* have a fresh brood every four or five weeks), and that a number of additional species make their appearance at that season only. On the other hand, during the dry season, although a number of migratory birds depart northwards, yet we have a considerable number of resident insectivorous birds, including rollers, drongos, shrikes, flycatchers, bush-king-

fishers, etc., and owing to the warmth of the midday sun, even in mid-winter, the lizards are always more or less active, and the insectivorous mammals are probably in no way reduced. With the insects it is very different; owing to the parching up of the vegetation the hosts of phytophagous insects disappear almost entirely, and the diminution in insect-life is enormous, being most noticeable among the Coleoptera and least so among butterflies, of which latter almost two-thirds have winter broods; and moreover their lives would be rendered even more precarious by the generally adverse conditions of their environment from climatic causes. It therefore seems clear that the struggle for existence would fall pretty severely on butterflies during the winter, owing to their general conspicuousness, and that such is actually the case is shown by the numerous instances of the development of a highly-protective under-side coloration during the dry season among *Satyrinæ*, *Nymphalinæ*, *Lycænidæ*, and *Pierinæ*. That the struggle is sufficiently keen, however, to compel unpalatable species to adopt protective coloration I should not like to say. The following is, I take it, a complete list of the South African genera possessing more or less undoubted distasteful qualities: *Limnas*, *Amauris*, *Acræa*, *Planema*, *Pardopsis*, *Neptis*, *Pentila*, *Alæna*, *Mylothris*, and *Pontia hellica*, and with the exception of *Acræa* none of these exhibit any change of colour during the winter which can possibly be construed as protective. Dealing therefore with *Acræa*, I find that even in this genus a considerable number of species such as *horta*, *neobule*, *anemosa*, *acara*, *encedon*, *cabira*, etc., exhibit only a comparatively insignificant seasonal dimorphism or even none at all. There remains therefore a group composing such insects as *violarum-asema*, *nohara-halali*, *petræa*, *doubledayi-axina*, *atolmis*, *burtoni*, etc., in which the dimorphism is fairly strongly marked in one sex or the other, and an interesting feature about this group is that they are all, with the exception of *petræa*, frequenters of open country, having a low flight and frequently sitting on the ground. It is also noticeable that this group, unlike the other, presents a very marked difference in the sexes, and wherever this is not the case, both sexes have a distinctly obscure coloration as compared with their congeners, *e. g. axina* and *asema*; further, that where the summer males exhibit any exceptional brilliancy, as *petræa*, *atolmis*, or

*nohara*, it is always compensated for by an exceptional dulness on the part of their respective females. I fear I do not feel sufficiently competent to attempt an explanation of the above facts, but I think you will agree that as a whole they hardly bear out the suggestion that distasteful species are compelled to adopt protective colouring in winter through the keener struggle for existence; and for the present I am tempted to incline to the view that the less marked cases of dimorphism may be attributable to purely climatic causes. The colouring of the other open veldt *Acrææ*, viz. *halali*, *axina*, and *asema*, is somewhat puzzling; for in the two latter it is far from being very brilliant or conspicuous; in *halali*, the male in summer is very brilliant, but the blackish or brownish grey of the female is certainly protective, and the insect when alarmed is very hard to follow with the eye in its low dodging flight over the herbage. In the winter the colouring of both sexes of all three species is certainly not very conspicuous among the withered grass. Either their unpalatability must be of a low order, or else they must be more subject to attack by some particular enemies than the woodland species. I should not be surprised if the rollers, of which we have five species, or cuckoos (also five) were to eat Acræas, as they are all far from particular as to their diet."

This hypothesis concerning certain of the smaller Acræas had been in Mr. Marshall's mind for a long time. Thus he wrote in 1896 from Natal:—

"*Estcourt, Oct.* 15, 1896.—I have an idea that all the species of the genus *Acræa* are not protected equally by nauseous taste, etc., and some of them perhaps not at all; for in many of the smaller species there is a marked seasonal dimorphism which has clearly a protective value. Now such a change seems hardly in keeping with warning coloration, which must be constant to impress itself on the minds of enemies, and moreover a species which requires protection by seasonal dimorphism cannot be very much protected in other ways, not to mention the fact that its colouring cannot be both warning and protective at the same time. There is, of course, nothing to show how much of the seasonal change we can attribute to climate alone. For instance, in comparing the slight alteration in an *A. acara* with the marked change in female *A. petræa*, are we to suppose that the dark-grey female of the latter

is due solely to climatic influence, and that such a change in the former is checked by the necessity for keeping the warning coloration uniform, or are we to consider that the slight change in the former is all that climate can effect, and that in the case of *petræa* this slight climatic effect has been enhanced by some other cause—presumably protection? Personally I incline to the latter view, but in either case it is clear that there are varying grades of protection by distastefulness in the genus."

An extract from another letter states the same important conclusions as to the severity of the struggle during the dry season.

"*Salisbury, March*, 10, 1898.—There are very few butterflies (South African, at least), exclusive of the admittedly protected species and their mimics, of which the bright colour cannot be explained on the *Teracolus-Kallima* basis. The most evident exceptions are *Byblia*, certain species of *Precis*, as *sesamus* (form *natalensis*), *eryne*, etc., which are practically coloured the same below as above, and *Belenois severina* and *mesentina*. The first I will admit has been so far a stumbling-block to me, though I am not yet prepared to accept it as a protected species. Provided that my ideas on seasonal variation in *Precis* be correct, these would also fall under the same heading as *Teracolus*, for like them they only assume the protective under-side colouring during winter, when attacks from birds are no doubt a great deal more to be feared, owing to the almost complete absence of *easily-caught* prey, such as beetles and other small insects; the summer forms probably are very little molested by birds, owing to their great agility and alertness, and the profusion of other insects at that period; they do, however, not unfrequently fall a prey to the rock-lizards, which stalk them with much astuteness, as I have observed on several occasions.

"With regard to *Belenois* my mind is still open, for it is a very curious genus, containing as it does the above two species which might perhaps from certain considerations be considered protected, and at the same time a species like *B. gidica* which evidently comes under the *Teracolus* heading, and lastly *B. thysa* which, to my mind at least, is clearly a Batesian mimic."

After a consideration of the evidence brought forward above, it will be generally admitted that the struggle for

existence is far keener in the dry winter season, and that butterflies are especially subject to it.

The most distasteful forms, many of which are the models for mimicry, are sufficiently protected to retain their conspicuous aposematic appearance throughout the year, and either exhibit no change in the winter season or a change which is not in any way cryptic.

While this is true of all the larger and most conspicuous Acræas, some of the smaller Acræas do exhibit changes in a cryptic direction in their winter generations. These are Acræas which, from their colouring and habits, may be inferred to possess only a moderate degree of unpalatability as compared with the other species of the genus.

Cases in which colouring is "warning and protective [procryptic] at the same time" are quite common, *e. g.* the protected larvæ of many *Tenthredinidæ* which harmonize sufficiently well with their food-plant to be concealed at a little distance, but assume the most conspicuous aposematic attitudes and movements as soon as they are discovered and disturbed. But in the case of the smaller Acræas suggested by Mr. Marshall, the colouring which is most procryptic does not occur at the same time as that which is less procryptic or probably aposematic. Mr. Marshall's numerous experiments upon the edibility of the smaller Acræas (see Sections 9, 18, 19) do not support the view that any of them are palatable to the insect-eating animals made use of. It has already been pointed out that the refusal or evident dislike of insect food by captive animals is trustworthy evidence of unpalatability, while acceptance is not proof of palatability (see p. 317). The smaller Acræas furthermore fall into beautiful syn-aposematic groups (see pp. 492, 493): indeed a strong Müllerian association can be recognized throughout almost the whole of the Ethiopian representatives of the genus, as was first suggested by Professor Meldola (Ann. and Mag. Nat. Hist., ser. 5, vol. x, 1882, p. 425).

It is therefore probable that these smaller Acræas are still specially protected, although to a less extent than other species of the genus, but that the keener struggle of the dry season has compelled them to produce generations which are inconspicuous as compared with those of the wet season.

If these interpretations here suggested be correct, the parallelism with *Precis sesamus*, etc., is very remarkable.

In the *Acræinæ* we find that the least unpalatable species of an unpalatable and conspicuous family have been compelled to produce relatively inconspicuous generations in the severe struggle of the dry season: in the *Nymphalinæ* we find that some of the less palatable species of a comparatively palatable and inconspicuous family have been compelled to produce strongly conspicuous generations in the wet season when more edible insect food is abundant.

The interpretation I have here suggested was put forward very cautiously in a note, dated Nov. 1898, to a short paper on Mr. Marshall's results with *P. sesamus* in the Proc. Ent. Soc. Lond., Oct. 5, 1898, pp. xxv, xxvi. The note points out that insects with warning colours are not to be seen in an English winter. "Those such as *Coccinellidæ*, which exist in the perfect form, hide themselves. The reason probably is that the amount of palatable food available is not sufficient to make it safe to rely on unpalatability, accompanied by warning colouring [see also 'Colours of Animals,' London, 1890, pp. 179, 180]. Experiments with hungry animals support this view. It is possible that the conditions are similar in South Africa [it is perhaps unnecessary to state that *organic* conditions were alone referred to], and that warning colours are more characteristic of the wet than of the dry season, thus affording greater opportunities for mimetic resemblance. If it should hereafter be shown that *Precis* is to some extent unpalatable, and that its resemblance to an Acræan type is synaposematic rather than pseudaposematic, the parallelism with our own fauna would be even closer, the conspicuous species which hide and thus adopt procryptic habits being represented by one which gives rise to another brood with markedly procryptic colouring and habits."

Mr. Marshall in commenting on this note records the following interesting observations on the habits of South African Coleoptera as determined by damp and dryness.

"*Salisbury, Feb.* 12, 1899.—Do you think that the English *Coccinellidæ* really hide in winter owing to their increased danger from enemies, and not from climatic causes? I ask the question because in this country Coleoptera are highly susceptible to weather. They appear to be for the most part absolutely dependent on moisture, this being especially noticeable among the terrestrial forms such as *Cicindelidæ, Carabidæ, Psammodes,*

*Anomalipus*, etc. These insects appear with a rush as soon as the early rains have saturated the ground, but should a dry spell supervene, they disappear as rapidly as they came, only to emerge again on the recurrence of a good rain. The case of the dung-beetles has always puzzled me, for here we have a large family of powerful and apparently hardy beetles, which have a constant supply of food all the year round, and yet they are unable to stand out the winter in the imago state, although a delicate butterfly can do so. In fact, the *Copridæ* are quite as dependent on moisture as the large *Carabidæ*, and are only to be seen at work from November to March, retiring even then during the dry spells."

The interesting effects of dryness described above certainly cannot be produced in our damp winters, and it is difficult to believe that our cold can be the cause of the retirement of *Coccinellidæ*, etc., when species of insects closely allied to those of England can endure to be frozen stiff and brittle in a temperature of 50 degrees below zero (F.) in a Manitoban winter.

Another letter from Mr. Marshall, received about the same time, contains a different comment upon the interpretation suggested by the present writer in 1898 and here amplified.

"*Salisbury, Jan.* 8, 1899.—I can fully perceive that any arguments that may be brought forward in support of the contention that *Precis sesamus* (*natalensis* form) is an example of incipient mimicry are equally applicable to the suggestion of incipient warning coloration, and for the present it must remain a matter of opinion as to which is the correct explanation, though the alertness of the insect and its undoubted palatability, so far as lizards are concerned, seems to lend more support to the former view to my mind." [See also Ann. and Mag. Nat. Hist., ser. 7, vol. ii, July 1898, p. 35.]

It has been here shown that there are important elements in the under-side coloration of the wet phases of *Precis sesamus* and *P. antilope* which cannot be explained as mimicry, Batesian or Müllerian (see pp. 425–8), while the entire appearance of the under surface of *P. archesia* form *pelasgis* can only be interpreted as a warning character (pp. 428–431).

The conspicuous appearance of the under-sides of these forms is doubtless chiefly adapted to render them con-

spicuous during the attitude of rest. There is probably a certain parallelism with cryptic under-sides, such as those of our *Vanessidæ*, which have no particular meaning in flight and when the insect alights, but still remains fully on the alert. The *resting attitude* is specialized in relation to the development of cryptic colours and patterns on the under-side, and in this attitude cryptic insects are always inconspicuous. Apart from the evidence of adaptation in the direction of conspicuousness on the under-side of the wet phases of *Precis*—the strongest argument for the presence of some distasteful quality—the mere existence of such an appearance in a palatable species is inconsistent with the explanation of cryptic under-sides as the product of adaptation in the direction of concealment from enemies.

The successful attacks of a species of lizard may be analogous to other well-known instances in which special enemies, such as the cuckoo, are known to devour conspicuous unpalatable insects.

Two other arguments in Mr. Marshall's paper (Ann. and Mag. Nat. Hist., ser. 7, vol. ii, July 1898, p. 30) must be met here. First, the suggestion that the brilliant colours of *natalensis* are due to the impunity with which such a development can arise in the limited struggle for existence in the stations occupied by the species, and the abundance in the wet season of other insect food (*loc. cit.*, pp. 35, 36). Such a suggestion does not explain the under-side coloration, and especially the evidences of adaptation in it. Secondly, Mr. Marshall meets de Nicéville's and Weismann's contention, that both seasonal forms "must be adaptive, otherwise the non-adaptive form would be gradually supplanted by its more favoured relative," by the suggestion that the dry-season phase may be a recent development which is even now actually supplanting the wet phase (*loc. cit.*, pp. 36, 37). It is, however, difficult to believe, looking at the *Nymphalinæ* as a whole, and especially the nearest allies of the species under discussion, that the conspicuous under-side of the wet phase is ancestral, and the cryptic under-side of the dry phase recent (see p. 430), so that the argument set forth above seems to me untouched. Mr. Marshall has indeed shown that the dry phase of *P. artaxia has* actually supplanted the wet phase (*nachtigalii*) in forest regions, where the struggle for existence is far more uniform at all seasons of the year than it is in the more open woodland country

in which the dry and wet phases alternate. The displacement of one form of *artaxia* by another is however no evidence of relative age, but only of relatively better adaptation to the conditions which obtain in the area where the displacement has occurred. Hence the observation recorded by Mr. Marshall seems to me strongly to confirm de Nicéville's and Weismann's conclusion that when both seasonal phases exist, both are adaptive.

Mr. Marshall also shows on pp. 421 to 423 that the species of *Precis* entirely restricted to forest regions possess cryptic under-sides and habits all the year round, although the dry-season generations are more completely cryptic.

It is not difficult to understand the observations referred to above,—viz. that the appearance and habits while cryptic all the year round should be more cryptic in the generations of greatest stress. Thus Mr. Marshall describes the wet-season phase of the purple-tipped South African *Teracoli* as having under-sides not specially well adapted for concealment on the ground during the resting attitude, and without the habit of suddenly settling when pursued, modes of concealment adopted by the dry-season generations. In such examples the success of the adaptations may be equal in the two seasons because of the difference in the intensity of the struggle. But the extreme seasonal phases of *Precis* can never be thus understood, because the wet forms are not merely less cryptic than the dry, they have gone over into the opposite camp, and have developed a very extreme, and, except in the examples of mimicry and warning colours, an unknown degree of conspicuousness.

Another and very interesting form of seasonal dimorphism is that which has been well known for a long time in the *Satyrinæ*, and consists chiefly in the development of conspicuous ocelli, especially upon the under-side of the wet phases and their greater or less suppression in the dry. No interpretation of the change has, so far as I am aware, been attempted, except that of Portschinski, which has been further alluded to and criticized on p. 398. I think it is probable that a valid interpretation is suggested by the result of an experiment made in 1887, and witnessed by Professor Meldola as well as by me. A specimen of *Canonympha pamphilus* was introduced into a lizard's cage. "It was at once obvious that the lizard was greatly interested in the large eye-like mark on the under-side of the fore-wing: it examined the mark intently, and

several times attempted to seize the butterfly at this spot. The observation seems to point to, at any rate, one use of the eye-like markings which are common on the under-sides of the wings of butterflies," viz. in order to attract the attention of an enemy, and thus divert it from more vital parts ("Colours of Animals," London, 1890, pp. 206, 207). The same interpretation is suggested by the habits of many species which expose an eye-spot as soon as they settle, when they are likely to be seized by an enemy which has marked them down to their resting-place, but quickly lower the wings and conceal the spot, so that they are far more likely to be concealed from an enemy which has not been specially directed to the exact place by seeing them alight. (Much confirmation will be found on pp. 371–5, where Mr. Marshall's injured specimens are described.)

Such directive marks may well be an advantage in the wet season, when enemies with an abundance of other insect food are less keen in their pursuit of butterflies, but in the far greater stress of the dry season we can understand how they would become a danger, and how the only chance of the survival of the species lies in the adoption of a cryptic appearance, and cryptic instincts in their most extreme and unqualified form.

This explanation has much in common with that suggested for the seasonal phases of *Precis*. Indeed, it is of much interest to observe that *nachtigalii*, the wet form of *P. artaxia*, has precisely the same relationship to the dry form as that described above in *Satyrinæ*. It is far less cryptic than the leaf-like dry phase, but it is not conspicuous. The ocelli on the under-sides of both wings and the strongly-marked hind margins, together with the specially prominent apex of the fore-wing, are probably directive characters which divert the attention of an enemy from the vital structures, when the insect is at rest with its wings closed.

The relationship of the interpretation in *Precis* to that just suggested in *Satyrinæ*, and to that offered in certain smaller Acræas (see pp. 433–7), renders it on the whole improbable that there is any alternation in degrees of unpalatability corresponding to the alternation in the seasons. There is, however, no *à priori* difficulty in the hypothesis that a higher degree of unpalatability may be correlated with the conspicuous colouring of the wet phase of *Precis;*

and experiments specially undertaken in order to test the suggestion would be of much interest. That the hypothesis is improbable is further shown by a long series of experiments (hitherto only published in abstract in the Report of the British Association, Manchester, 1887, p. 763) which I conducted in 1887 with lizards and the highly insectivorous marmoset. Large numbers of the imagines of *Vanessa io* and *V. urticæ* were made use of, and I came to the decided conclusion that both were somewhat unpalatable. They were certainly only eaten when the insect enemies under observation were hungry. Now the strongly cryptic under-side of both species associated with a fairly-conspicuous upper-side renders them in every way comparable to the dry phases of *Precis*. The results of my experiments suggest that if *Vanessa urticæ* appeared on the wing in the teeming organic environment of Africa in the wet season—with far more enemies but an even greater preponderance of palatable insects—it would be to its advantage with its present degree of unpalatability to acquire a conspicuous under-side coloration, and thus to ensure easy recognition and rejection with comparatively little loss of life by experimental trials.

The considerations set forth above suggest what will probably hereafter be proved to be true, that a degree of unpalatability associated with a conspicuous appearance in the tropics will often appear associated with a cryptic appearance in the Holarctic Belt as well as in those areas of the tropics in which for special reasons the amount and variety of insect life is greatly restricted.

It is suggested on pages 475 to 477, that this is the interpretation of the loss of much of the aposematic appearance of *Limnas chrysippus*, var. *klugii*, on desert areas in the tropics.

To return to the seasonally dimorphic Ethiopian species of the genus *Precis*, if the two phases have been produced, as is here contended, by natural selection working in opposite directions because opposite kinds of adaptation are advantageous in the very different organic environments of the wet and dry seasons, the questions as to the way in which the change is actually determined, and as to the existence of any kind of susceptibility to external influences connected with the seasons, are still unanswered. The considerable amount of labour devoted by Mr. Marshall to the solution of this problem has up to the present

yielded negative results. Before describing his experiments and discussing the results, it is desirable to show the mode of succession of the phases in the wild state. By far the most complete evidence I have been able to obtain relates to a single species, *P. sesamus*.

### G. *The succession of the two Seasonal Phases of* Precis sesamus *in Nature.*

The following extracts from Mr. Marshall's letters from 1897–1900 give an account of his experience of the succession of wet and dry forms of this species in the wild state, and also show how the conviction was gradually forced upon him that the early appearance of occasional specimens of the dry phase in the heart of the wet season is not due, as he thought at first, to exceptional climatic conditions (see also his paper in Ann. and Mag. Nat. Hist., ser. 7, vol. viii, Nov. 1901, p. 402).

"*Malvern, Natal; March* 12, 1897.—You will notice that the dry forms of several species made their appearance at the Karkloof in the middle of February: this is most unusually early. I do not know whether it is a feature and characteristic of that locality or whether it is due to the abnormally dry weather during that month, which is usually one of the wettest in the year. The average rainfall for this February was considerably lower than it has been for twenty years. It is true that *here* the insects are still all of the true summer form, but the proximity of the sea may account for that."

"*Salisbury, March* 6, 1898.—*Sesamus* was unusually early here this year, appearing at the beginning of February, full six weeks before its usual time. This I am inclined to attribute to the exceptionally dry January and February we have had—normally our wettest months—though I am aware that Weismann considers that exceptional seasons have little or no effect on seasonal forms, which certainly does not accord with my experience in S. Africa."

"*Salisbury, Feb.* 12, 1899.—I send a specimen of *P. sesamus* ⊙ captured on Jan. 27, 1899, on which day I also saw another. These two examples are of considerable interest as bearing on the problem concerning the stimulus which actually induces seasonal change in this species.

In a normal wet season (in which there are more or less continuous heavy rains from the middle of December to the end of February) *P. sesamus* ⊙ appears at the end of March. Last season we had heavy rains up to the end of December 1897, but January was unusually dry and *sesamus* ⊙ appeared on Feb. 6, being the earliest record I had for it. This season the drought was still more severe in January and commenced earlier, viz. about Dec. 12. This has been accompanied by a still earlier appearance of *sesamus* ⊙. The evidence so far as it goes tends to show that climatic conditions, in some cases at least, are directly capable of inducing the change and upsetting the normal alternation of the forms. Here, owing to highly abnormal conditions, we have the dry form occurring at what is normally the very height of the wet season. Moreover, ever since I have observed seasonal dimorphism in butterflies I have noticed the effect of abnormal weather in retarding or accelerating the appearance of either form, and Barker has made similar observations at Malvern, near Durban, Natal."

"*Salisbury, April* 25, 1899.—The *sesamus* form is evidently more dominant than the *natalensis*, for despite the heavy rains in February 1899 the latter made very little headway after the appearance of the dry-season form; whereas among such insects as the *Pierinæ* the result of the alternating extremes was much more evident."

"*Salisbury, Feb.* 7, 1900.—In spite of our heavy rains during January (16·75 inches for the month) the winter forms of *Precis* are appearing just as early as last year, which has puzzled me considerably. I shall send you the first examples of each form captured."

"*Salisbury, June* 26, 1900.—I am afraid I am not yet convinced as to the automatic alternations [viz. due to the organism itself and not to external stimuli] of the seasonal forms in *P. sesamus*; there seems to be at present an equal amount of evidence on either side, and until the matter can be settled by an exhaustive series of experiments I must retain an open mind on the question."

I have given below a list of all the specimens of the two phases of *Precis sesamus* sent to me from Mashonaland by Mr. Marshall.

| LOCALITY. | OBSERVER. | DATE. | FORM OF *Precis sesamus* IN HOPE COLLECTION. |
|---|---|---|---|
| Mazoe, 4000 ft. | G. A. K. Marshall. | Dec. 28, 1894. | 1 *natalensis*, fresh. |
| Gadzima, 4200 ft., Umfuli River. | G. A. K. Marshall. | Dec. 20, 1895. | 1 *natalensis*, fresh. |
| | | Dec. 23, 1895. | 3 *natalensis*, fresh. |
| Salisbury, 5000 ft. | G. A. K. Marshall. | March 20, 1895. | 1 *sesamus*, fresh. |
| | | Feb. 13, 1898. | 2 *natalensis* (in coitu). ♂ worn, ♀ fresh. |
| | | Feb. 20, 1898. | 1 *natalensis*, fresh. |
| | | Feb. 27, 1898. | 1 *natalensis*, worn (parent of 1 *sesamus*, and 1 *natalensis*). |
| | | March 2, 1898. | 1 *sesamus*, fresh. |
| | | March 6, 1898. | 1 *natalensis*, worn (parent of 1 *sesamus*). |
| | | March 12, 1898. | 1 *sesamus*, fresh. |
| | | March 16, 1898. | 1 *sesamus*, fresh. |
| | | April 2, 1898. | 1 *sesamus*, fresh. |
| | | Jan. 27, 1899. | 1 *sesamus*, fresh (the first seen in 1899). |
| | | March 11, 1899. | 1 *natalensis*, worn. |
| | | Feb. 3, 1900. | 1 *sesamus*, fresh (the second seen in 1900). |
| | | Jan. 23, 1901. | 1 *natalensis*, fresh. |
| | | Jan. 26, 1901. | 1 *sesamus*, fresh (the first seen in 1901). |
| | | March 2, 1901. | 1 *sesamus*, fresh, transitional towards *natalensis*. |
| | | April 8, 1901. | 2 *sesamus*, fresh. |

A study of the above list makes it probable that the occurrence of occasional specimens of the dry phase of *sesamus* in January and February is a normal overlap.

Very careful and numerous records over a large number of years would be required to show that any change in the relative time limits of the two forms is taking place.

Owing to the kindness of Mr. S. L. Hinde, H. M. Sub-Commissioner, East African Protectorate, and Mrs. Hinde, I have received a most interesting series of the two forms from British East Africa, probably near the northern boundary of the range of the species. The numbers, captured in a short time on a limited area, are sufficient to enable us to judge of the relative proportions of the two forms, and we see that in May and the beginning of June the two occur mixed in about equal proportions, while in December and January the wet phase greatly predominates, although an occasional dry form appears, as it does in Mashonaland, early in January. I have included in the series two other specimens from near the northern part of the range of *P. sesamus*. The whole list is wonderfully similar to that from Mashonaland, and supports the view that Mr. Marshall's observations record the normal mode of replacement of the wet by the dry phase, although the former persists in large numbers much later in the north than it does in the south.

| LOCALITY. | OBSERVER. | DATE. | FORM OF *Precis sesamus* IN HOPE COLLECTION. | CHARACTER OF THE SEASON AT WHICH CAPTURE WAS EFFECTED. |
|---|---|---|---|---|
| N. Kikuyu Country, 5000 ft. | H. J. Mackinder and C. B. Hausburg. | Aug. 1899. | 1 *sesamus*, fresh. | The heart of the big dry season. Butterflies very scarce. |
| Near Mengo, Uganda. | Mrs. Leakey. | May 30, 1900. | 1 *natalensis*, fresh. | |
| Machakos Road. | S. L. and H. Hinde. | May 22, 1900. | 6 *natalensis*, mostly worn.<br>6 *sesamus*, fresh.<br>The 12 insects captured in less than an hour on a patch of ground a few yards in extent. | The end of a very dry wet-season in an exceptionally dry year. |
| Machakos. | S. L. and H. Hinde. | June 6, 1900. | 2 *natalensis*.<br>1 variety nearer to *natalensis*.<br>3 *sesamus*.<br>1 *natalensis*, is worn, all others fresh. The 6 insects captured together as above. | As above, only well into the dry season. Two or three days' heavy rain had intervened between this date and May 22. |
| Kitui. | S. L. and H. Hinde. | Dec. 11, 1900. | 4 *natalensis*, mostly worn. | After the rains of the small wet season, and in the beginning of the small dry season. |
| | | Jan. 2, 1901. | 4 *natalensis*, mostly fresh.<br>1 *sesamus*, fresh. | Nearly in the middle of the small dry season. |
| | | Jan. 8, 1901. | 1 *natalensis*, little worn. | Nearly in the middle of the small dry season. |
| | | Jan. 12, 1901. | 1 *natalensis*, fresh. | Nearly in the middle of the small dry season. |

The succession of the seasons is very different, in the region in which Mr. and Mrs. Hinde captured the butterflies, from that which obtains in Salisbury. The two forms of succession are shown in parallel columns below.

| BRITISH EAST AFRICA (MACHAKOS, KITUI, ETC.). | | MASHONALAND (SALISBURY, MAZOE, GADZIMA). | |
|---|---|---|---|
| Mid-October to Mid-December | Small wet season (about 17—18 inches). | Early November to Mid-April | Wet season, average rainfall of Salisbury about 35 inches. |
| Mid-December to Mid-March | Small dry season. | | |
| Mid-March to end May | Big wet season (about 17—18 inches). | Mid-April to Early November | Dry season. |
| end May to Mid-October | Big dry season. | | |

It is to be observed that the rainfall of the small and the big wet seasons are about the same, and also that the country is not really dried up in the small dry season except in unusually dry years. The country is always dried up in the big dry season.

In spite of these great differences in the seasons, the succession of the phases is wonderfully alike in the two areas, as has been pointed out above. We must conclude that *sesamus* can produce two seasonal phases annually but not more, so that the small dry season of the north is no more effective in producing the dry phase than the simultaneous wet season of the south. The species is so constituted that it produces a dry phase for the big dry season and a wet phase for the rest of the year, some of the dry-phase individuals being produced some months before the normal change takes place, viz. at and just before the beginning of the chief dry season. The difference between the date at which this great change of seasons takes place in north and south is attended by a corresponding difference in the date at which the wet phase of *sesamus* gives place to the dry. Both lists are unfortunately wanting at the transition from the big dry season to the wet. There is indeed only a single record for the period between the beginning of June and the beginning of December. Speaking from memory, Mr. Marshall thinks that the break from *sesamus* to *natalensis*

at the beginning of the wet season is not sharp; indeed, he has a distinct recollection of seeing them flying together at that season fairly frequently. "I believe," he writes (1902), "that in some seasons one might take *sesamus* in every month of the year. Certainly at Gadzima, in 1895, the true winter broods of *sesamus* lasted right up to the end of December. In a dry spring, that is when the rains are late in starting, butterfly life appears to be less abundant and the emergence of the wet-season forms seems to be retarded. On such occasions an actual break without specimens might occur in such a comparatively unfavourable locality as Salisbury. But I believe that this would be an unusual occurrence, and even if it happened in one locality I doubt if it would necessarily take place everywhere at the same time; for example, in the moister parts of the low veldt the succession of the broods would probably continue unbroken. I am quite satisfied that there are at least two or three broods of *sesamus* during the winter months, that is if the condition of wild specimens can be taken as any criterion. Food is much less plentiful in the winter, but it is obtainable in quite sufficient quantities to keep the species going. The change of seasons from wet to dry is of rather a gradual character; the reverse change is more marked, but this depends a good deal upon the total rainfall of the preceding year. When this has been heavy, the ground retains a certain amount of moisture throughout the winter, so that when the frosts cease and the sun's heat increases in the spring, a large number of the earlier plants spring up and flower before a drop of rain has fallen. But after a succession of dry years this does not take place, and, with possibly a few exceptions, none of the plants come out in response to the heat, but require the rains to bring them out. In this latter case the change in conditions is very strongly marked, much more so than during a wet cycle."

The discussion of the possible nature of the environmental stimulus, if any, is better deferred until after the description and consideration of Mr. Marshall's experiments in the next section.

H. *The attempt to control the Phases of* P. sesamus *and* P. archesia *by the artificial application of Moisture and Heat to the earlier stages. Suggested lines of Experiment.*

All the experiments hitherto made by Mr. Marshall were directed towards the production of the wet *natalensis* and *pelasgis* phases in place of the dry *sesamus* and *archesia* respectively. The whole of the specimens produced were presented by Mr. Marshall to the Hope Collection, and all are tabulated below, together with a statement of the experimental conditions which were employed in each case. All experiments were made at Salisbury.

The following extracts from Mr. Marshall's letters refer to some of the experiments on *sesamus*:—

"*Salisbury, June* 5, 1898.—I kept two larvæ in a damp jar, but one did not attach itself properly when pupating, and the resulting pupa fell down when soft and was killed. The other larva produced a black pupa which emerged as the wet form [April 13, 1898, in the Table below], but this was rendered nugatory by the fact that one of the larvæ in normal conditions produced the same form, though from a gilded pupa [April 20, 1898, in the Table below]."

"*Salisbury, April* 25, 1899.—I have fourteen bred specimens of *P. sesamus* which I will send later [specimens in year 1899 in the Table below]; I tried some experiments with them, but the results are mostly negative. There are two interesting varieties, one with a red bar in the discoidal cell and another with the red spots much reduced."

| NUMBER OF EXPERIMENT. | DATES OF EARLIER STAGES. | SURFACE ON WHICH LARVA SUSPENDED ITSELF. | COLOUR OF PUPA. | CONDITIONS OF HEAT AND MOISTURE. | DATE OF EMERGENCE. | PHASE OF *P. sesamus*. | SEX. | WEIGHT ON JUNE 30, 1902. |
|---|---|---|---|---|---|---|---|---|
| 1 | Larva suspended Feb. 19, pupated Feb. 21. | White paper. | Gilded. | Dry heat Feb. 21—28. | March 1, 1899. | 1 *natalensis*. | ♀ | ·07322 grammes. |
| 2 | Larva suspended Feb. 21, pupated Feb. 22. | Crimson paper. | Black. | Dry heat Feb. 22—March 1. | March 6, 1899. | 1 *sesamus*. | ♂ | ·08422 grammes. |
| 3 | Larva suspended Feb. 22, pupated Feb. 23. | White paper. | Gilded. | Dry heat Feb. 23—March 2. | March 6, 1899. | 1 *sesamus*. | ♀ | ·07897 grammes. |
| 4 | Larva suspended Feb. 24, pupated Feb. 24. | White paper. | Gilded. | Dry heat Feb. 24—March 2. | March 9, 1899. | 1 *sesamus*. | ♀ | ·10422 grammes. |
| 5 | Larva suspended Feb. 24, pupated Feb. 25. | White paper. | Gilded. | Dry heat Feb. 25—March 2. | March 10, 1899. | 1 *sesamus* (with red bar in cell of fore-wing). | ♀ | ·08522 grammes. |
| | Larva suspended Feb. 24, pupated Feb. 25. | White paper. | Gilded. | Dry heat Feb. 25—March 2. | March 10, 1899. | 1 *sesamus*. | ♀ | Not weighed; mended specimen. |
| 7 | Larva suspended March 3, pupated March 4. | White paper. | Gilded. | Damp heat March 17, 7 p.m. to March 18, 2 p.m. | March 19, 1899. | 1 *sesamus*. | ♂ | ·07772 grammes. |
| 8 | Larva suspended March 9, pupated March 10. | White paper. | Gilded. | Damp heat March 17—21. | March 22, 1899. | 1 *sesamus*. | ♂ | ·05272 grammes. |
| 9 | Larva suspended March 11, pupated March 12. | Green stem in white box. | Gilded. | Damp heat March 17—23. | March 24, 1899. | 1 *sesamus* (red spots much reduced; bright blue shade of ground-colour). | ♀ | ·06972 grammes. |
| 10 | Pupated April 1. | — | — | Damp March 23. | April 13, 1898. | 1 *natalensis* (*sesamus* dominant in nature in middle of March). | ♀ | ·04647 grammes. |
| 11 | Egg laid March 6, hatched March 12, pupated April 7. | — | — | Damp March 30—April 5. | April 30, 1898. | 1 *sesamus*. | ♂ | ·07172 grammes. |
| 12 | Egg laid Feb. 27, hatched March 5, pupated March 31. | — | — | Normal. | April 15, 1898. | 1 *sesamus*. | ♂ | ·06447 grammes. |
| 13 | Egg laid Feb. 27, hatched March 5, pupated April 5. | — | — | Normal. | April 20, 1898. | 1 *natalensis* (but somewhat dark variety). | ♀ | ·06722 grammes. |
| 14 | Larva suspended Feb. 26, pupated Feb. 27. | Brown paper. | Black. | Normal. | March 13, 1899. | 1 *sesamus* (dark with small red spots). | ♂ | ·07847 grammes. |
| 15 | Larva suspended Feb. 27, pupated Feb. 28. | Brown paper. | Gilded. | Normal. | March 13, 1899. | 1 *sesamus*. | ♂ | ·07372 grammes. |
| 16 | Larva suspended Feb. 28, pupated March 1. | Brown paper. | Gilded. | Normal. | March 16, 1899. | 1 *sesamus* (largest red spots of all these imagines). | ♀ | ·10097 grammes. |
| 17 | Larva suspended Feb. 28, pupated March 1. | Brown paper. | Gilded. | Normal. | March 15, 1899. | 1 *sesamus* (very dark with small red spots). | ♂ | ·09097 grammes. |
| 18 | Larva suspended March 3, pupated March 4. | White paper. | Gilded. | Normal. | March 19, 1899. | 1 *sesamus*. | ♀ | ·09397 grammes. |

The experiments on the power of adaptation of the pupal colours to their environment are very interesting, and prove that the susceptibility resembles that of the allied British species *Vanessa urticæ*. They also show that there is no essential difference between the colours of the pupæ of the two phases, but merely an adaptive response to environments which differ in colour at the two seasons, as suggested by Mr. Marshall (Ann. and Mag. Nat. Hist., July 1898, p. 33). It is clear, from the experiments, that if withered leaves of the usual winter yellow appeared, owing to exceptional circumstances, in the summer, larvæ suspended to them would produce gilded pupæ instead of the usual dark summer forms, and, *mutatis mutandis*, larvæ would produce dark pupæ upon dark leaves in the winter.

The highest form of procryptic defence, viz. the power of each individual to respond adaptively to any of its different normal environments, here exists in the helpless pupal stage, although the under-side of the wet phase of the imago can only be interpreted on the supposition that natural selection has developed a conspicuous appearance. Our own *Vanessidæ* however offer examples of the same kind of association in the different stages of a single life history. Thus the pupæ of *V. urticæ* and *V. io* have the same specialized power of concealment, while their gregarious black larvæ are excessively conspicuous and the imagines themselves by no means palatable to certain enemies of insects (see p. 442).

No special significance appears to attach to the varieties of the imagines produced in these experiments. The red bar in the cell of No. 5 is a common variety which indeed appears to be universal in the dry phase of the West African *P. octavia*, and red scales can be detected in this region in a large proportion of the individuals of *P. sesamus*. The red spots of No. 5 are not specially developed. The latter were largest in an individual exposed to normal conditions (No. 16), while Nos. 14 and 17, also exposed to normal conditions, were among the specimens with the smallest spots. The bright blue shade of the ground-colour of No. 9, exposed to damp heat, is well known in captured specimens from the most northern part of the range of the species as well as the south.

The specimens were weighed on an Oertling's balance, each pinned on a small cork foot which weighed ·06275 grammes on June 29, 1902, and ·00025 grammes more on

June 30. The weight of the No. 16 pin (D. F. Taylor's) was obtained by weighing three sets of ten similar pins. The weight of the first ten was ·7960 grammes, of the second and third ·7950 grammes. The average weight of a pin was therefore ·07953 grammes, and this number added to ·06275 was deducted from each of the specimens weighed on June 29 (see p. 456): added to ·063 it was deducted from the specimens of the experiments recorded above, and all others weighed on June 30 (see pp. 451, 456). On the latter date the cork foot was weighed at the beginning of work, in the middle, and at the end. On all three occasions it weighed ·063 grammes.

The consideration of the experiments on *Sesamus* is better deferred until after describing those upon *archesia*, although it is at once evident that no positive conclusions can be drawn as to the nature of the environmental stimulus. The negative character of the results obtained induced Mr. Marshall finally to form the opinion quoted below.

"*Salisbury, Feb.* 26, 1902.—I do quite agree with you now that in the case of *Precis* the evidence is sufficiently strong to show that climate has ceased to operate as the stimulus which calls forth the seasonal change. But I do not think that this view is applicable to other genera whose changes coincide closely with the changes in climate. The theoretical proposition I would suggest is that at its inception seasonal change was but slight and then due entirely to climatic action, such cases doubtless occurring at the present time. Any markedly useful variations of this kind would then be preserved and accentuated by natural selection, but climatic causes would still remain the controlling factor. Finally, as in *Precis*, the influence of natural selection would attain its maximum, and the seasonal changes would then take place solely as a result of this principle and irrespective of the influence of climate. It remains to be seen whether this can be proved by experiment."

On pp. 455 to 458 it will be seen that there are still hopes that the operation of some environmental stimulus may yet be discovered in the case of *Precis*.

The results obtained from the smaller series of experiments upon *P. archesia* are even more negative than those yielded by *P. sesamus*, as will be seen by a glance at the Table below, giving a complete account of all that has been as yet done.

| DATES OF EARLIER STAGES. | | CONDITIONS. | DATE OF EMERGENCE. | RESULT OF EXPERIMENT. |
|---|---|---|---|---|
| — | | Normal. | April 20, 1899. | 1 *archesia*. |
| Pupated March 28. | | Normal. | April 14, 1899. | 1 *archesia*. |
| Offspring of same parent-*pelasgis*. | Egg laid March 22, hatched March 27, pupated April 24. | Normal. | May 7, 1899. | 1 *pelasgis* } *archesia* had replaced *pelasgis* about beginning of April. |
| | Egg laid March 22, hatched March 28, pupated April 26. | | May 14, 1899. | 1 *pelasgis* } |
| Pupated April 14. | | Damp heat April 14—22. | April 28, 1899. | 1 *archesia*. |
| Recorded in Ann. Mag. Nat. Hist., November 1901, p. 400. | Pupated April 17. | Damp April 16—May 6. | May 8, 1901. | 1 *archesia*. |
| | Pupated April 30. | Damp April 28—May 17. | May 21, 1901. | 1 *archesia*. |
| | Pupated May 6. | Damp May 5—May 28. | May 30, 1901. | 1 *archesia*, var. *staudingeri*. |

Concerning the specimens which emerged on May 7 and 14, and April 28, 1899, Mr. Marshall wrote as follows:—

"*Salisbury, Aug.* 29, 1899.—The case of *pelasgis* and *archesia* was very puzzling, as the results were just the opposite of what one would expect—the forced pupa emerging as the dry-form *archesia*, and the normal ones as the wet-form *pelasgis*, though this latter has disappeared for some time, being replaced by *archesia*."

The negative results from these fairly-numerous experiments tempt us to believe that the change from *sesamus* to *natalensis* and *natalensis* to *sesamus* may be fixed in the constitution of the species, and may form an alternating series contemporaneous with the alternating seasons but not causally connected with them. Such a view is however rendered improbable, as Dr. Dixey has pointed out to me, because there would be nothing to prevent a gradual shifting and finally an entire want of parallelism between the two series. That, however, the change is essentially constitutional in the species and merely requires some external stimulus to set it going may be taken as certain. Furthermore, it is not necessary to suppose that a stimulus is required for *both* changes, the return to one of them, and presumably the more ancestral, may be in the nature of a rebound. The slight but distinct difference between the succession of the forms of *sesamus* in British East Africa and in Mashonaland also probably indicates a causal relation with the inorganic environment, and the same conclusion is supported by the fact that *artaxia* has been observed without its wet-season phase in a forest region (see pp. 422–3).

After Mr. Marshall's experiments it is difficult to believe that the application of heat or moisture or the two combined to the pupal stage can determine the production of *natalensis* or *pelasgis* in place of *sesamus* or *archesia*, respectively, at the period when the latter forms are becoming abundant in nature. It is possible that here we are merely witnessing the return to a more ancestral phase due to purely internal causes. The reverse experiment, viz. the application of cold, or dryness, or both combined, to pupæ of the earlier generations of *natalensis*, might produce more positive results and cause the appearance of *sesamus* at a time of the year when it is very rarely seen, although the occurrence of occasional individuals of *sesamus* in nature in the depth of the wet season seems to

be quite unrelated to dryness or cold (see pp. 443–8). But it would probably be necessary to apply artificial conditions to the larval stage. Indeed, the fact that the winter phases of certain species of *Precis* are so very much larger than the summer phases seems to require the conclusion that the change is pre-determined during or previously to the stage in which material is accumulated.

The differences in weight are well shown in captured individuals of two species in the following list: the method of procedure has been already described on pp. 452–3. It is seen that the dry phase always weighs more and sometimes over twice as much as the wet one.

| SPECIES. | SEX. | LOCALITY. | DATE OF CAPTURE. | PHASE. | WEIGHT. FIRST 2 ON JUNE 29, REST ON JUNE 30, 1902. |
|---|---|---|---|---|---|
| *Precis antilope.* | ♂ | Salisbury. | March 2, 1898. | Wet. | ·03422 grammes. |
| *Precis antilope.* | ♀ | Salisbury. | Feb. 27, 1898. | Wet. | ·03747 grammes. |
| *Precis antilope.* | ♀ | Salisbury. | April 3, 1898. | Dry. | ·07472 grammes. |
| *Precis antilope.* | ♀ | Salisbury. | March 9, 1898. | Dry. | ·04947 grammes. |
| *Precis artaxia.* | ♂ | Umtali. | Dec. 27, 1900. | Wet. | ·05597 grammes. |
| *Precis artaxia.* | ♀ | Umtali. | Dec. 30, 1900. | Dry. | ·09672 grammes. |
| *Precis artaxia.* | ♂ | Umtali. | Dec. 30, 1900. | Dry. | ·08447 grammes. |
| *Precis artaxia.* | ♀ | Gadzima, Umfuli R. | Dec. 29, 1895. | Wet. | ·06622 grammes. |
| *Precis artaxia.* | ♂ | Gadzima, Umfuli R. | Dec. 30, 1895. | Wet. | ·05422 grammes. |
| *Precis artaxia.* | ♀ | Gadzima, Umfuli R. | July 29, 1895. | Dry. | ·06997 grammes. |
| *Precis artaxia.* | ♀ | Mazoe. | Dec. 28, 1894. | Wet. | ·04522 grammes. |
| *Precis artaxia* (worn). | ♀ | Mazoe. | Oct. 23, 1894. | Dry. | ·09547 grammes. |

It may be argued that the results from captured specimens are untrustworthy because some females will have laid their eggs, some males will have paired, and others not. The five series of specimens of *sesamus* and *natalensis* bred by Mr. Marshall are not open to this objection and

are therefore of especial value. The weights of the eighteen bred specimens are given on p. 451, and it will be seen that the difference between the phases is very marked, although not nearly equal to that between the two forms of *artaxia*.

There is no escape from the conclusion that the larvæ of the dry phase of these species must be much larger than those of the wet, and must eat a great deal more food. This inevitable conclusion suggests that in experimenting on this most interesting of all known examples of seasonal change, it will be well to keep an open mind on all conceivable stimuli: on the abundance and character of the food-plant as well as the inorganic conditions of humidity and temperature, the latter of which has been proved by Dorfmeister, Weismann, Merrifield and Standfuss to be an effective stimulus in the case of certain Palæarctic seasonally dimorphic species. It is possible that the parched state of the food-plant towards the end of the dry season may be the stimulus which determines development in the direction of the smaller summer phase. The different sizes and weights render it nearly certain, as I have argued above, that the phase is predetermined in the larval stage. Now the larval stage of the first dry-season brood is passed in the wet season, and that of the first wet-season brood probably in the dry. We must look to some condition affecting one or both of these larval stages, or the eggs from which they arose, as the stimulus which sets in motion the organic processes resulting in a change of phase. Some colour of support is lent to the suggestion that the condition of the food-plant may afford the necessary stimulus by the fact that the wet phase of *P. artaxia* is unknown in certain forest regions, where it is probable that the food is not subject to the same alternation of condition as in more exposed stations. But forests would also act as moderating influences for extreme differences in temperature and humidity, and thus tend to prevent these from acting as stimuli for the species in question; for we know that some stimuli must be effective in producing such seasonal changes as occur in other forest species of *Precis* (see p. 423). Finally, quantity as contrasted with condition of food would be well worth trying. The unusually low weight of the imagines bred from the egg (Expts. 11, 12, and 13 on p. 451) was a probable result of difficulty in obtaining a constant supply of fresh

food in an entirely normal state, and it is noteworthy that one out of the three was *natalensis*. The extremely low weight of the ♀ *natalensis* in Expt. 10 also suggests some unfavourable condition in the larval state.

With the facts before us I do not see that any further suggestions can be made at the present moment; but I think the tables of weights clearly indicate the period at which the stimuli should be applied, while temperature, humidity, quantity or quality of food, or some combination of these, seem to exhaust all probable influences in the direction of a change of phase.

## I. *The Bearing of the Seasonal Phases of* Precis *upon the Science of Insect Systematics.*

The results which have been described and illustrated in this section of the present memoir are so startling that they may well shake the confidence of naturalists in the whole fabric of insect systematics. If such forms as *natalensis* and *sesamus*, as *simia* and *antilope*, as *pelasgis* and *archesia*, are nothing but the generations of two alternating phases of a single species, approximately synchronized with the heat and cold or humidity and dryness of the alternating seasons, naturalists may feel driven to ask, "What becomes of the validity of specific distinctions?" Between the two phases of *Precis sesamus* there are extraordinary differences in colours, pattern, shape of wings, relation of upper- to under-side, nay, even in instinctive habits, including the choice of particular stations. This latter distinction between the phases is but the outward expression of some profound difference in the intimate structure of ganglionic centres and intercommunicating strands in the central nervous system. Important differences in venation are incidentally brought about by the great differences in the shape of the wing. The extreme rarity of intermediate varieties furthermore recalls the abrupt transitions which are so common, although very far from universal, between species of animals which are assumed to be distinct. Under the shock of Mr. Marshall's discovery that *sesamus* and *natalensis* are two forms of the same species, the systematist may well feel doubts about the foundations upon which his science has been erected. In these distracting circumstances a firm belief in natural selection will be found to

exercise a wonderfully calming and steadying influence. The structures which are adopted as the conventional criteria of specific distinction are of course modified by natural selection and brought into adjustment with new conditions of the struggle for existence as one species is gradually changed into another; but they are also capable of modification in one and the same species as it passes through various conditions during its life-history and in sexual and other dimorphism. The species frequently requires that the female sex should be more protected than the male, and hence we often witness a more perfectly cryptic appearance and habits in the female, and mimicry in the female alone. In many kinds of di-, tri- and polymorphism we see a species more perfectly protected at one and the same time by extending the area over which it must be sought by its enemies—in cryptic resemblance, earth and bark as well as leaves and shoots—in mimetic resemblance, Danaine or other distasteful models not of one species alone but two or more. In the di-, tri- or polymorphism of the social Hymenoptera and Neuroptera we see the specialization of the individual for the good of the community. In the extreme cases of seasonal dimorphism, exhibited by the genus *Precis*, there is a far less common modification of a species into two series of generations respectively adjusted to the conditions obtaining at two seasons of the year. But less marked cases of the same kind are probably not uncommon. There is however nothing revolutionary or subversive in any of these interesting facts. The conventional marks of specific distinction remain just as they were, convenient indications to the systematist, enabling him provisionally to separate groups of individuals into the assemblages we call species. When his work is done carefully subsequent breeding experiments will, we may be sure, confirm his conclusions in the majority of cases. But here and there startling exceptions will be found when it is to the advantage of a species to appear in two or more very different forms. In such cases the reason for the difference can generally be satisfactorily explained on the principles of natural selection; and when such an explanation is possible or even probable it is quite unnecessary to assume that the exceptions possess a numerical importance sufficient to shake the foundations of systematics.

Certain species are cryptic while others are aposematic

or pseudaposematic; certain stages in the life of an individual may be cryptic, others aposematic or pseudaposematic. There is nothing subversive in the thought that certain species exposed to different organic environments in two seasons of the year may appear as cryptic generations at one of these, aposematic or pseudaposematic at the other. The explanation is at any rate sufficiently probable to enable us to contemplate Mr. Marshall's wonderful discovery with equanimity and with an interest undisturbed by the thought that he has laid in ruins the whole edifice of insect systematics.

## 29. The Gregarious Instinct in Hybernation and Emigration of Insects. (E. B. P.)

The interesting observation that individuals of *Precis sesamus* are apt occasionally to congregate in large numbers as they go to roost, led me to reflect on the possible meaning of such an instinct. Mr. Marshall records other examples of the same kind "in species of *Euralia*, also in *Belenois, Herpænia criphia*, and *Teracolus eris*" (Ann. and Mag. Nat. Hist., *loc. cit.*, 1898, p. 34). It is possible that one interpretation does not explain all these cases, but I think it is probable that the observed instances of the congregating of *Precis* and *Euralia* are sporadic examples of an instinct which is associated with hybernation or, at any rate, a prolonged period of rest during a time of relatively excessive cold, heat, or dryness. Objection may be taken to this interpretation on the ground that large companies undergoing a prolonged rest ought to be well known in these species. It is possible however that the extreme conditions which render such a state desirable or even necessary for the species are not common, and, when they occur, do not conduce towards the active pursuit of natural history; furthermore, such prolonged rest would probably be passed through in some hidden recess which could only be found by accident.

Large numbers of naturalists for hundreds of years have been interested in the doings of *Vanessa io*, but, so far as I am aware, it is not generally known that this species may display a gregarious habit in hybernation.* My friend,

* Edward Newman recorded the occurrence of a company of more than forty *V. io* in a hollow oak (British Butterflies and Moths, London, N.D., p. 16), and the Rev. Joseph Greene disturbed three

Dr. W. Hatchett Jackson, the Radcliffe Librarian at Oxford, permits me to publish the following observation made by him at Weston-super-Mare in the second week of January 1895. Dr. Jackson found, in the garden of his house, on the side of a hill sloping south, about twenty peacock butterflies hybernating in the heart of a bramble-bush. The butterflies were arranged in rows on two or three approximately horizontal runners about a foot from the ground. All rested with their wings hanging downwards. When the butterflies were first disturbed they made no movement, but on repeated disturbance they

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specimens in the hollow formed by the arching roots of a large beech-tree, in Dec. 1852 (G. C. Barrett, British Lepidoptera, London, 1893, vol. i, p. 139). W. S. Coleman (British Butterflies, London, 1862, p. 88) quotes Doubleday in the *Zoologist*:—"Last winter some large stacks of beech faggots, which had been loosely stacked up in our forest (*Epping*) the preceding spring, with the dead leaves adhering to them, were taken down and carted away, and among these were many scores of *io*, *urticæ*, and *polychloros*." No reference is given, and I have failed to find the original statement. An observation of Mr. Banning of Monte Video, Ballacraine, Isle of Man (also quoted by Coleman, l. c. p. 91), is recorded in the *Zoologist* (1856, p. 5000) :—"Whilst standing in my farmyard on the day following Christmas Day [1855], it being unusually fine and warm, I was suddenly astonished by the fall of more than a hundred of the accompanying butterflies [*Vanessa urticæ*]. I commenced at once collecting them, and succeeded in securing more than sixty. . . ." This observation apparently points to the emergence of a hybernating assemblage in consequence of exceptionally warm weather. It also indicates conditions which at a normal time of the year would be favourable to pairing.

Mr. J. W. Tutt states that the imagines of *V. io* feed largely during August, disappearing at the end of the month or in September (Entomologist's Record, 1895–6, vol. vii, p. 3). It is therefore probable that the butterflies produced by one company of larvæ do not keep together, or the fact would certainly have been noticed when they are in search of food. It is probable that the products of all companies scatter and become thoroughly intermingled before again assembling into groups for hybernation. Another line of evidence may perhaps yield incontrovertible proof of the existence of this intermixture before reassembling—a probable adaptation to prevent in-and-in breeding. Dr. W. H. Jackson and Mr. O. H. Latter, F.E.S., have found that the pupæ obtained from different batches of larvæ of *V. io* "were principally, but not entirely, of one or of the other sex" (Trans. Linn. Soc., London, vol. v, 1890, p. 156). It would not be difficult to obtain a numerical statement of the average constitution of a company in this respect, so that it would be available for comparison with that of a hybernating group. A marked difference would prove intermixture before hybernation, while a similar constitution would yield negative evidence.

flicked their wings and the movement passed along the row. It must be remembered that the climate of Weston is extremely mild, and the great frost of 1895 had not then begun.

The advantages of a period of rest during excessive heat and dryness may be as great as those which follow from excessive cold. In the former the food-plant may be parched and dry or confined to very few and widely-scattered damp spots, and the perfect insect may pass through its life without the chance of laying eggs in places where the larvæ would be able to survive. But quite apart from this, the continuous excessive drought may be injurious to the perfect insect itself. At the driest and hottest part of the African dry season a great scarcity even of common butterflies has been noticed, and it is not unlikely that many individuals of some species pass through the most critical period of very dry and hot years concealed in a state of rest. It is significant that the congregating instinct has only been observed in the dry phase of *Precis sesamus*.

This does not solve the problem of the gregarious instinct itself. It is clear that Dr. Jackson's observation on *V. io* and Mr. Marshall's on *Precis*, etc., indicate the existence of an instinct which must be a real and great danger to the species. The less the individuals congregated and the more widely they scattered, the greater would be their chance of safety. A fortunate enemy finding one of the peacocks in the bramble-bush at Weston would have secured the whole. It is therefore certain on the principles of natural selection that some great advantage is gained by the instinct, an advantage which more than compensates for the increased danger. I would suggest that this advantage is the facility given for pairing and the laying of eggs without any loss of time, as soon as the period of rest comes to an end. The advantage would be quite as great or even greater after the rest during drought than after ordinary hybernation, because of the rapidity with which the food-plant recovers with the first moisture. It would be interesting to consider from this point of view the food-plants of the African species in which the instinct has been observed.

This suggestion naturally leads to a consideration of the gregarious instinct in the peculiar form of emigration which has been observed in insects. The same increased

dangers attend the phenomenon, and I think it is very probable that they are more than compensated by the analogous benefits. The instinct to emigrate probably exists in a dormant state in all species liable from their powers of rapid multiplication suddenly to outrun the food-supply in any part of their range. The stimulus which evokes the instinct is, in such insects as the locust, or such mammals as the lemming, probably merely the direct and obvious incentive of hunger (A. R. Wallace, "Geographical Distribution," London, 1876, vol. i, p. 18). In the majority of perfect insects, however, we cannot accept this interpretation, and we are compelled to look for a stimulus in some other result of undue increase—the crowds of individuals everywhere, the food-plant covered with eggs and young larvæ, and females laying still more eggs. Then probably arises the imperative instinct to move, perhaps in both sexes, perhaps only in the female, the males accompanying them (in many species in far larger numbers). And the instinct further compels the individuals to move together in vast masses in the same direction, rather than to scatter and fly in all directions. The increased danger from enemies is of course lessened, as compared with the hybernating companies, by the enormous number of emigrating individuals; but there is, I believe, the solid advantage that fresh food-plant may be found in another uncrowded area; that the limits of the normal range of the species may be overpassed; that areas from which the species has been driven may be regained:—not by single individuals or by a very few pairs, but by immense numbers of both sexes without any of the dangers of in-and-in breeding when once they have established themselves as a fresh colony. In this way the range of many species has probably been extended in the past, and, although the emigrating crowds so often described may again and again be landed in a foodless desert or the sea, the instinct is advantageous in that it utilizes individuals which are at the moment useless and even injurious to their kind, in a manner which may be in a high degree beneficial (see also Trimen, "South African Butterflies," vol i, 1887, p. 31). The suggestion is made that the crowded masses, resulting from over-production and inability of enemies to cope with the increase, are injurious to the species, because it is likely that food-plants would be checked for years or even killed

out altogether in certain localities, while the heaps of dead individuals would encourage the attack and rapid spread of bacterial foes. Indeed, the advantages to be derived from the removal of the surplus from an overcrowded area may probably overweigh those which accrue from the occasional successes in colonization, and may more than the latter account for the development by natural selection of the instinct to move. The massing of the moving individuals and their flight in the same direction seem, on the other hand, to have arisen by selection from the beneficial results conferred by spreading into less crowded areas. It is difficult to imagine any other possible means by which such animals as insects could overcome the effects of a sudden increase too great for the restraining influences of their natural enemies—effects which insufficiently checked for a few generations would inevitably lead to the destruction of the species in the area of overproduction.

We may well inquire why it should be necessary for such emigration, with a possible successful issue in colonization, to require the services of countless individuals when the importation of half-a-dozen rabbits or a few specimens of *Pieris rapæ* will, for the naturalist, change the face of a continent. The results of these unintentional, or intentional but ill-considered, experiments do indeed shake the belief in the paramount necessity for crosses and the dangers of in-and-in breeding; but the end is not yet, and the teeming colonies which have arisen from such small beginnings may in time vanish from the operation of deep-seated causes. The varied adaptations for cross-fertilization and the prevention of in-and-in breeding are so evident in nature, that we are compelled to believe that they meet and counteract serious dangers which sooner or later would menace the very existence of the species. And among other adaptations it is significant that the instinct under discussion should lead to the streaming of large populations, and not of small batches of individuals from an area of high pressure.

The gregarious instinct in emigration has been observed in many groups of insects beside the Lepidoptera. I need only mention here the hundreds of *Ammophila hirsuta*, ordinarily a solitary species, found by Fabre under a large flat stone on the summit of Mont Ventoux at a height of 6000 ft., and the crowds of ladybirds witnessed by him

on the same mountain and on the tableland of St. Armand ("Insect Life," English translation, London, 1901, p. 193). A valuable account of a large number of observations will be found in Mr. J. W. Tutt's numerous papers on "The Migration and Dispersal of Insects" (Ent. Record, 1898–1902). The author recognizes the dangers of over-multiplication as a cause of migration (l. c. vol. xii, 1900, p. 238: see also vol. xiii, 1901, p. 200). Numerous examples quoted by him prove that movement in vast bands, often at great distances from land, has been observed again and again in those very species which are remarkable for their wide geographical distribution and occurrence upon oceanic islands. The appearance of two species of *Hybernia*, *H. defoliaria* and *H. aurantiaria*, observed in large numbers in Heligoland by Gätke, cannot be explained on the hypothesis here suggested because, the females being flightless, males only appeared. In several other instances recorded by Mr. Tutt the presence of both sexes is either specially affirmed or implied. In the great majority of cases, however, no observations of sex were made, and it is to be hoped that careful attention may be paid to this point in the future. The proportion of females to males would also be deserving of careful investigation.

The limits of this memoir are perhaps too wide already, and it is impossible to attempt any discussion of these observations in detail, but I have taken the opportunity of making a suggestion as to the possible essential meaning of the instinct.

I have deliberately used the word "*emigration*" of insects, because this term probably expresses the exact state of the case. In response to some stimulus connected with undue increase, immense masses of individuals *move out of* an overcrowded area. The line of movement may carry them to destruction or to plenty, in both cases benefits are probably gained, although they are of course much greater in the latter. True "*migration*" as of birds and perhaps of fishes implies different and far higher faculties—the memory of the individual summed up by tradition into what may be called the collective memory of the species.

30. Description and Discussion of Material bearing on Mimicry in South African Rhopalocera collected by Guy A. K. Marshall, and the Record of Observations made by him. (E. B. P.)

The splendid material which is described and discussed below has gradually accumulated as the result of Mr. Marshall's kind and generous response to my desire for specimens for the Hope Department illustrating the fact that mimetic species and their models, and the members of large convergent or synaposematic groups, not only inhabit the same areas but fly together at the same time. The study of this material naturally led to conclusions and suggestions which it is hoped possess a general interest in relation to the doctrine of evolution and the important part which mimicry plays in it, as one of the chief evidences of the operation of natural selection. These more general discussions are placed under separate headings immediately after the groups whose study gave rise to them.

The last sub-section is placed under Mr. Marshall's name, being quoted *in extenso* from his letters.

A. *Black-and-White Amauris-like Group.*

The central model for the group described below is probably *Amauris ochlea*, but it was not captured on March 27, 1897, when five convergent individuals were taken at Malvern, near Durban, Natal. The group as captured is as follows:—

*Planema aganice* ♂.
„ *esebria* ♀, var. with white markings.
*Neptis agatha* ♂.
2 *Nyctemera leuconoë*.

The male *Planema aganice* is but an imperfect member of the group, the lighter markings being buff instead of white, as in the female. We thus find that the latter sex forms closer synaposematic resemblances than the male, when the two sexes differ. It is probable that this relationship between male and female will be found to be generally true of Müllerian mimics in which the sexes exhibit different degrees of likeness to the type of some group characterized by Common Warning Colours. Furthermore, the culmination is often reached in Müllerian

mimicry, just as it is in Batesian where it has long been recognized, in species of which the female enters into a more or less well-marked membership of a group towards which the male has made no apparent approximation. Numerous examples will be found in the present memoir.

This interesting similarity between Müllerian and Batesian mimicry was probably unrecognized until 1894, when it was discovered by F. A. Dixey,* because of the fact that in the first-known examples of Müllerian mimicry in tropical America, which are the most wonderful instances in the world, the convergent pairs and groups contributed by the *Heliconinæ* and *Ithomiinæ* and by different genera within each of these sub-families, are made up of species with males and females which are superficially alike.

Now, however, that the principle has been recognized by Dixey in many Neotropical Müllerian mimics with differing sexes and here in many Ethiopian, the explanation is doubtless the same as that suggested by Wallace (Trans. Linn. Soc. xxv, Pt. I, 1865) in the case of Batesian mimics, viz. the great importance for the species that the female, with her slower flight and the necessity to pause and lay her eggs, should gain to the full the advantages of that extra advertisement of warning coloration which is conferred by membership in a synaposematic group. This is the interpretation offered by Dixey in his 1894 memoir (q. v.).

*Neptis agatha* exhibits in an interesting manner that concentration of white markings into four large patches, one upon each wing (save that the fore-wing is invaded by a small portion of the hind-wing patch), and that disappearance of the other bars and markings, except for traces on the under-side, which are characteristic of many Ethiopian species of this genus, and doubtless indicate a synaposematic approach to the black-and-white species of *Amauris* and *Planema* of the Region.

It is too wide a subject to introduce into the present memoir, but I cannot forbear to allude to the evident synaposematic sensitiveness of the genus *Neptis*, leading it to form associations with local conspicuous Rhopalocera. Among the most beautiful of these are *N. venilia* and *N. lactaria*, which resemble the remarkable Danaine genus *Hamadryas*, especially upon the under-side. Again, the

* Trans. Ent. Soc. Lond., 1894, p. 298, note; 1896, pp. 70, 71; 1897, pp. 319, 326–328, 330.

likeness to *Athyma* and *Limenitis* must have struck every naturalist who has looked through the drawers of a tolerably large collection. Col. Swinhoe has recently called my attention to a *Euploea*-like *Neptis* from China, *N. imitans*.

The resemblance of the genus *Neptidopsis* to *Neptis* seems, on the other hand, to have been due to mimetic approach on the part of the former towards the type set by the latter.

The Hypsid moth *Nyctemera leuconoë* seems to have independently adopted the same aposematic scheme of colouring as the genus *Amauris*, the only change in the direction of the latter dominant type being a slight broadening of the white bar crossing the fore-wings, a broadening which is at once recognizable when this and other African species of the moth are compared with their nearest Oriental allies. The conspicuous and almost certainly specially-protected *Hypsidæ* strongly tend to enter into synaposematic association with other specially-defended forms in various parts of the world. Thus one species approximates towards *Hamadryas*, while, in tropical America, the smaller forms become transparent and resemble the smaller *Ithomiinæ*, while the larger (*Pericopis*) possess the warning coloration of species of *Melinæa* and *Heliconius*.

### B. *Limnas chrysippus-like Groups.*

The first of these groups was captured on March 6, 1897, at Malvern, Natal. It consists of the eight following individuals:—

*Limnas chrysippus* ♂.
„ „ ♀, var. *alcippoides*.
*Hypolimnas misippus* ♀, with pale hind-wings like the last-named insect.
*H. misippus* ♀, var. *inaria*.
*Planema esebria* ♀, *chrysippus*-like type-form with white sub-apical bar to fore-wings and reddish-brown black-bordered hind-wings, the ground-colour extending on to the fore-wings.
*Acræa encedon* ♂.
*A. serena*, var. *buxtoni*, ♀.
*A. doubledayi* ♂.

The latter individual, being a male, is not really a member of the group, inasmuch as it lacks the oblique

sub-apical white bar present in the female of typical *doubledayi*. The presence of the male indicates, however, that the female flies with the other members of this *chrysippus*-like group, of which it forms an imperfect and outlying constituent. The male of *serena* also does not resemble *chrysippus*, while the female is an even more imperfect Müllerian mimic than the female of *doubledayi*. Nevertheless such cases are of the highest interest, inasmuch as they enable us to understand how mimicry arose in species which now exhibit a startling likeness. *A. encedon*, one of the most perfect Müllerian mimics of *chrysippus*, presents an equally close approximation in male and female.

The fact that the female of *P. esebria* should present two well-marked varieties, one of which falls into a black-and-white group convergent round the species *Amauris*, while the other, the type-form, enters the combination which surrounds *L. chrysippus*, recalls a principle already well known and probably correctly understood in the case of Batesian mimicry. When an abundant well-protected *Acræa* thus approximates to two very different Danaine patterns it is obvious that we are not necessarily driven to a Batesian interpretation of the forms of the female *Papilio cenea*, which approximate to the appearance of *Amauris echeria* as well as to the two other Danaine types alluded to above. The enemies of *chrysippus* and the species of *Amauris* are certainly not precisely the same, and it may well be an advantage to a Müllerian mimic to secure that increased protection from insect-eating enemies which is conferred by belonging to two or more groups.

Furthermore, the Planema has come to resemble the Danaine and not the Danaines the Planema, and this probably indicates that the Danaine is on the whole the less attacked and the better known. It is probably of advantage to the whole group that the Danaine which set the pattern should still be the dominant member of the assemblage of which it is the centre. This dominance is favoured by the individuals of an abundant species joining two or more groups instead of throwing the whole of their number into a single one. In the case of Batesian mimicry, where the mimics are comparatively palatable and would be freely eaten if recognized, the advantage of this di- or trimorphism and the likeness to two or three models is even more obvious.

A second group of the same type was captured in the same locality on March 30, 1897, and consists of six individuals:—

*L. chrysippus* ♀.
*H. misippus* ♀, a pale patch in the centre of each hind-wing.
*P. esebria* ♂, buff sub-apical bar to fore-wing.
*A. encedon* ♂.
*A. serena*, var. *buxtoni* ♀.
*A. petræa* ♀.

The lack of correspondence between the varieties of the females of *H. misippus* and those of the central member of the group is well seen in these two sets. Thus one of the three females is the *inaria* form, although the *klugii* var. of *chrysippus* is almost unknown in S. Africa, while the other two suggest the appearance of the *alcippoides* var., which does indeed occur not uncommonly, but is not nearly so abundant as typical *chrysippus*. The female of *A. petræa* is another outlying member of the group, while the male is altogether outside it.

A third group, captured by Mr. Marshall at Salisbury on April 10, 1898, contains these species:—

*L. chrysippus* ♀
*H. misippus* ♀
2 *A. encedon* ♂
} all typical forms.

A fourth group captured at the same locality on April 9, 1899, contains:—

2 *L. chrysippus* ♂, ♀ (Plate XIV, figs. 1, 1*a*).
2 *Mimacræa marshalli* ♀ (Plate XIV, figs. 2, 2*a*).

This beautiful Lycænid mimic presents in some respects a closer approximation to *Acræa encedon* (Plate XIV, figs. 3, 3*a*) than to *L. chrysippus*, the primary model of both. Thus the character and contour of the sub-apical white bar of the fore-wing suggests that of the Acræa rather than the Danaine. In the two former the bar is more continuous, in the latter more obviously broken into discontinuous spots, attended by outlying smaller spots. Another far more important similarity between Lycænid and Acræa is brought about by the numerous conspicuous black spots which in both are scattered over the basal part of the under-side of the hind-wing. In other respects the

under-side of the Lycænid presents a much closer approximation to the Danaine than does the Acræa. In well-marked individuals there are fourteen of these spots in the Lycænid, nineteen in the Acræa. In place of these, the Danaine model possesses, in addition to the marginal white-marked spots and a single spot at the extreme base of the wing, only a row of three spots on the outer boundary of the cell in the female, with an additional white-centred black patch, marking the scent-pouch, in the male. The three spots along the outer margin of the cell are encircled with white, as are all the spots in the Lycænid; while the veins of the under-side of the hind-wing in both are more or less emphasized with white. In these minor but distinct points the Lycænid approximates to the Danaine and not to the Acræa; and furthermore in the fact that the black spots of the under-side of the hind-wing are hardly visible on the upper-side of the Lycænid, while all except the basal ones are as distinct upon the upper- as upon the under-side of the Acræa. In the Danaine they are very distinct although much smaller on the upper-side, but as there are only three in the female and four in the male, the Acræa is in this respect much further from the other two than they are from each other, its distance being still further increased by a few (4—6) large conspicuous black spots on the ground-colour of the basal half of both surfaces of the upper wing. It is noteworthy that these points of divergence on the part of *A. encedon* are characters which it shares with a large number of related species. All the points mentioned above can be well seen in the six upper figures of Plate XIV, which should be compared with the six corresponding figures on Plate XV, showing the prevalent form of the Danaine model and its Acræine and Lycænid mimics much further north in British East Africa.

In the dark shade of the brown ground-colour the Acræa is much nearer to the Danaine as developed in S. Africa than the Lycænid, and upon the wing the black spots would probably make the Acræa appear still darker. The bright fulvous tint of *M. marshalli* is more of the shade of the Oriental specimens of *chrysippus*. This relationship appears to exist between many of the other African Müllerian and Batesian mimics of *L. chrysippus* and their model, and suggests that the Oriental bright shade is ancestral, although the Oriental intrusion is comparatively

modern, as proved by the relatively small amount of mimicry, and that little very imperfect, in species peculiar to the Region. The fact that the bright Oriental shade still persists in many of the specimens of *chrysippus* from the north-east and probably other parts of Africa, supports the same conclusion.

Mr. Roland Trimen points out that the *Mimacræa* also resembles the female of the type-form of *Planema esebria* (Trans. Ent. Soc. Lond., 1898, p. 15).

Mr. Marshall gives the following account (1902) of the habits of this interesting insect:—"In its general habits *Mimacræa marshalli*, Trim., like *Acræa encedon*, is essentially a woodland (but not a forest) insect, and shows a marked fear of venturing out into open country. *Limnas chrysippus*, on the other hand, frequents both open and woodland stations. When quite undisturbed it flits about in a limited area of the bush with a slow flight exactly resembling that of *L. chrysippus* (see also pp. 481, 482), but when alarmed it is capable of flying with considerable speed, and dodges with great dexterity. When hard pressed it will occasionally rise right over the tops of the trees, descending into the bush again further on. But its usual method of escape is by dodging in and out among the tree-trunks, then settling suddenly on the far side of one of them, which makes it extremely difficult to follow. It is in its resting habits that it differs most from the mimetic group to which it belongs, for I have never seen a specimen settle anywhere except on a tree-trunk, and then always with its head downwards, just like a *Libythea* or the brown species of *Crenis*. The Danainæ and Acræinæ, on the other hand, always rest with their wings hanging down, and usually in more exposed positions; indeed, I think it may be said that no species of these groups (in South Africa at least) ever settles upon tree-trunks. This habit is also a very unusual one among our Lycænidæ, one or two species of *Teriomima* being the only cases of its occurrence which I can recall. Despite the great resemblance of this *Mimacræa* on its under-side to *Acræa encedon*, yet its colouring when at rest is very far from conspicuous, and harmonizes a great deal better with its surroundings than might be supposed from an examination of the insect in the cabinet, especially as the fore-wings are so much depressed between the hind-wings as to quite conceal the sub-apical white patch. The species seems to be of

considerable rarity; I know of only fourteen or fifteen specimens, all of which, except two or three, were captured by myself."

### C. *The Origin and Meaning of the Three Chief Forms of Limnas chrysippus.*

I have often discussed the question set forth in the title of this sub-section with my friend Colonel J. W. Yerbury, who has observed this insect carefully in many of its localities, and is deeply interested in it.* He believes that the appearance of the various forms is controlled by environmental influences—dryness or moisture—acting upon the pupa at some critical period of special sensitiveness. The facts recorded below do not seem to be consistent with this interpretation.

My friends Mr. and Mrs. S. L. Hinde, who have kindly collected many specimens throwing light on problems to which I have given much thought (see also pp. 446, 447), sent me two series of forms of *Limnas chrysippus*, which are of special value in relation to this discussion.

The first set (of 15) was captured, almost on the sea-level, in the uniform damp heat of Mombasa, on May 6, 1900, and consists of four of the type-form of *Limnas chrysippus* (1 ♂ and 3 ♀), and eleven of the form *klugii* (9 ♂ and 2 ♀). All were taken in less than an hour on a spot of ground a few yards in extent. They thus afford a fair criterion of the proportionate numbers of the two forms.

The second set (of 13) was taken, at a height of about 5400 ft., at Machakos Road, on the Uganda Railway, on May 22, 1900, and consists of four of the type-form (3 ♂ and 1 ♀), one *alcippoides* (♂), seven *klugii* (2 ♂ and 5 ♀), and one *dorippus* (♂). These also were taken on a spot of ground a few yards in extent, in less than an hour.

Mr. Hinde has given me information as to the climate of the period in which the latter capture was made. It is printed on pp. 447, 448, but it is well to re-state here that May 22, 1900, was at "the end of a very dry wet-season in an exceptionally dry year." The specimens show the effect of these conditions, for they are on the average

* J. W. Yerbury, Journ. Bomb. Soc. Nat. Hist., 1892, p. 207. Col. Yerbury's observations on the species are also quoted by Dr. A. G. Butler in Proc. Zool. Soc. Lond., 1884, p. 478; 1885, p. 756.

*very much smaller* than those bred from larvæ which fed on the more luxuriant food-plant in Mombasa. Examining the two series, we are driven to the conclusion that the Machakos larvæ were partially starved, probably by feeding on parched food-plant. Interesting and important inferences may be drawn from the comparison.

In the first place the specimens, so far from supporting the conclusion often arrived at from incomplete and, as I think, ill-regulated experiments, that males are produced by starvation, actually show a larger number of females in a smaller total of specimens than the set from Mombasa, viz. 6 out of 13, as against 5 out of 15. Even if the females had been very scarce at Machakos, nothing would have been proved in the direction of the determination of the sex of the individual by diet, for starvation pushed to the extreme of preventing the completion of development of many individuals is certain to kill off the heavier sex far more freely than the lighter. The results, however, show no abnormal excess of males, and in every way support a prediction firmly founded on the anatomical fact that the essential organs of sex, the testis and ovary, are already present, rudimentary, but perfectly distinct, in the larval stage.

A comparison of the two series furthermore indicates very strongly that the various forms of the species are not in any way due to environmental causes, but are inherent and hereditary. It is believed that *klugii* is due to drought, but there is a larger proportion of this form in the series bred in the moist heat of the coast than in that reared at high and dry Machakos. The great difference in conditions which is manifest in the different average size of the two series was powerless to effect any change in the inherent hereditary tendency of the individual to become either *klugii* or its modification *dorippus*, the type-form or its modification *alcippoides*.

This comparison of forms from adjacent localities under different climatic conditions leads to an inference which is precisely the same as that drawn from the comparison of forms from different localities under the same climatic conditions. The tropical forests of West Africa and the Malayan Islands are very similar as regards climate: in the first *chrysippus* occurs as the white-hind-winged *alcippus*, in the second as the type-form, a peculiar dark form inhabiting Java (*L. bataviana*). It is not necessary

to pursue such comparisons further. So far as *chrysippus* is concerned, I know of no facts which support the hypothesis of the environmental production of the forms, and many which are inconsistent with it.

The only alternative hypothesis which presents itself is that of the operation of natural selection in determining the very different distribution of the various forms of *chrysippus* in the different parts of its range. And in attempting to solve this difficult problem I have been guided by the same principles which enabled me to suggest a meaning for the two widely-different seasonal phases of *Precis*, viz. the relation between insects and their enemies, the value of warning colours under certain conditions, their weakness and danger under other conditions. I believe that the condition of desert areas corresponds to that of the dry season, only differing in that they are more rigid, so that cryptic colouring is still more imperative. I therefore suggest that the *klugii* form is a development in a procryptic direction in areas where the struggle is so severe that even this most unpalatable and widely-mimicked species must put off some of its aposematic appearance, viz. the conspicuous black-and-white apex of the fore-wing.

There is also a peculiar faintly greenish-orange shade in the area of the apex of the fore-wing under-side beyond the sub-apical white bar of *chrysippus* which is wanting from the corresponding part of *klugii*, the difference tending to bring about a further uniformity in the ground-colour of the under-side of the latter.

Furthermore, many specimens of *klugii* have a ground-colour quite different from that of even light individuals of the type-form, gaining a distinct sand colour. This is all the more striking in Africa, where the type-form commonly develops a dark rich fulvous ground-colour very different from the paler Oriental type.

This interpretation is based on the assumption that *klugii* has developed from *chrysippus* and not *chrysippus* from *klugii*, and no escape from this assumption seems possible. The main lines of argument are these. Island individuals, which are so generally ancestral, are *chrysippus* and only *very* rarely *klugii*, except near the metropolis of the latter form in Somaliland. Perfect and imperfect mimics, Batesian and Müllerian, are very large in number, especially in Africa. Probably not one of them mimics

*klugii* and not *chrysippus*, a few mimic both, while the great majority mimic *chrysippus* alone. Again, *klugii* stands alone among Danaina, while the pattern of *chrysippus* is closely related to that of several other species and genera, such as *Salatura*. The distribution of *klugii* can be understood by supposing the desert region of Somaliland to be its centre. From this point it radiates, towards the east becoming gradually rarer, although it is well known in Karachi, and Colonel Yerbury even captured a single specimen in Ceylon, towards the south finally disappearing in South Africa, towards the Nile Valley, here also probably disappearing towards Central Africa. *Chrysippus*, or at least forms with a black-and-white apex to fore-wings, on the other hand, occur over the whole vast range of the species with the exception of certain parts of Somaliland.* The strongest argument is, however, one which is developed at the end of the section, because wide conclusions of great interest spring from it (see pp. 482–484).

The white-hind-winged *alcippus* was for a long time a great difficulty to me, but Mr. Marshall's suggestion (see p. 479) that it is a further development in the direction of still more efficient warning colours than the type-form seems to me to be sound, especially considering its distribution in the abundant life of the tropical West Coast, and considering the fact, of which Mr. Marshall assures me, that it is much more conspicuous on the wing.

I have for a long time thought that this great development of white, combined with the darkening of the fulvous ground-colour so common in African specimens and marked in *alcippus*, may indicate an incipient synaposematic approach to the black-and-white Danaina of the genus *Amauris*, and the large black-and-white *Acræinæ* of the genus *Planema*.

It is in favour of this view that the darkened ground-colour appears to be a recent development, although it has arisen in the Ethiopian region—the ancestral home of the species, if we may judge by the much larger number of mimics which resemble it in this part of its range. I believe the lighter ground-colour of *chrysippus* in India and, with certain exceptions, the East generally, formerly

* Consult Dr. A. G. Butler's map of the distribution of the forms of *chrysippus*, on Plate XLVI, accompanying his paper in Proc. Zool. Soc. Lond., 1884, p. 478; also by the same author, Proc. Zool. Soc. Lond., 1885, p. 756.

prevailed in Africa, because so many of its African mimics retain this shade rather than that now borne by their model, and because *chrysippus* itself often exhibits the paler tint, especially to the north and east * of the African continent (see pp. 471, 472.).

I quote below extracts from several of Mr. Marshall's letters dealing with the hypothesis which I have here set forth, and also referring in other ways to this interesting butterfly and its forms.

"*Malvern, May* 14, 1897.—I was interested to hear that the *L. chrysippus*, var. *alcippoides*, I sent resembles the West Coast specimens. Personally I have never come across that variety commonly, and those I have taken have mostly been very slightly marked with white, but Mr. G. H. Burn, who has collected for some years in the Tugela Valley, near Weenen, says they are not uncommon there, but apparently are most prevalent in the early winter (it is a very hot dry district), and they are frequently marked quite as strongly as the one I sent you."

"*Salisbury, Jan.* 24, 1900.—Referring to your very interesting remarks on *L. chrysippus*, I was much struck by your theory with regard to *klugii*. The only point, however, on which I do not feel satisfied is whether we can consider the colouring of this variety to be really protective. Of course I have never seen it in life, but I have seen many of the *inaria* form of *Hypolimnas*, and I must confess that the insect is very far from being inconspicuous; and even apart from colour it must be remembered that slowness of flight is a very important factor in rendering an insect conspicuous (compare our large and powerfully-armed but soberly-coloured wasps of the genus *Belenogaster*). Again, it would seem hardly consistent to regard the colouring of *klugii* as protective if we rank that of the smaller Acræas, which inhabit some at least of the same areas, as among the warning colours. It would therefore strengthen the theory if some other use could be assigned to the *klugii* coloration, though none occurs to me at the moment. Of course the correlation argument might be brought forward; but while thoroughly appreciating Meldola's masterly defence of this principle, I must admit that I have a distinct distrust in its use in such cases, as it means virtually begging the question. I cannot altogether gather from your remarks what are your reasons

* See F. A. Dixey in Proc. Zool. Soc., 1898, p. 373, note.

for supposing that the lighter Asiatic form is the older [see pp. 471, 476]. On general principles it would seem that swamping would be likely to keep the species more or less constant in its ancestral home, whereas those specimens that wandered further afield would probably tend to vary along slightly different lines: but perhaps I have not properly caught your idea. The case of *alcippus* would be a great deal more difficult to explain satisfactorily, seeing that it occurs also at Aden; and Butler says that examples sent from such places as Monbuttu, Wadelai, etc., by Emin Pasha, showed every gradation from *chrysippus* through *alcippoides* to *alcippus;* further, if I remember rightly, you wrote me that an example I sent you from the Tugela had the white developed as strongly as in any West Coast specimen, and Burn said they were by no means uncommon there."

["A. G. Butler records (Proc. Zool. Soc., 1896, p. 243) Captain Nurse's statement that in Somaliland he bred all four forms of *chrysippus* from quite similar larvæ." G. A. K. M., 1902.]

"*Salisbury, June* 26, 1900.—Referring to the question of *Limnas klugii*, although I fully appreciate the value of your arguments, yet I must confess that when looking at the matter from the point of view of an opponent of mimicry, it seems at least open to criticism. The difficulty seems to lie in the fact that the same coloration would thus have to be regarded as both protective and warning. Now you have said that in desert regions insects would be more liable to attack owing to the paucity of insect life, and I should be glad to know whether you have any special reasons for adopting this view, as I have no experience of what the conditions of life really are in such localities. But don't you think that it is more likely that the struggle for existence would be principally against climatic conditions and not so much a competition with other organisms, and that thus probably insects would have a better *proportionate* chance of finding a living than would the vertebrates as compared with more fertile regions? If this were so it would follow that insects would be comparatively freer from attack in desert regions, and this would afford us another explanation of the *klugii* phenomenon. We might presume that the less conspicuous *klugii* colouring was the more ancestral (as seems not unlikely), but that in the more fertile regions where

insectivorous vertebrates and invertebrates are so much more plentiful, this coloration was not sufficiently striking to guard it from the tasting experiments of these enemies, and thus the white bar would be gradually developed. The typical form would therefore supplant *klugii* in all places where there was greater need of more efficient warning colouring, and the latter form would only survive in those tracts where only a limited number of insectivorous enemies could exist. Such an explanation would further throw some light on the additional development of white in the hind-wing of *alcippus* in the prolific West Coast belt, where the increased number of vertebrate enemies requiring to learn by experience renders an additional conspicuousness advantageous. It seems to me that if such an explanation could be maintained it would be more consistent with our general views; but of course the matter hinges on the conditions of life in desert tracts, which is merely an assumption on my part."

"*Salisbury, Sept.* 21, 1900.—I was much interested in your remarks on the subject of *klugii*, and I quite agree that now that you have shown that my premise as to the conditions of life in desert countries is erroneous my contention falls to the ground. I should like to know how the range of the *inaria* form of *misippus* falls in with your proposition, and also whether you find the variety of *Acræa encedon* without the white bar to follow the same range as *klugii*. I have found this variety [*daira*] extremely rare in S. Africa, but a correspondent wrote me from Beira the other day that it was not uncommon there and promised to send me specimens."

"*Estcourt, Natal; Oct.* 15, 1896.—I had thought *Acræa encedon* might be mimetic, but it must be a case of convergence—the type towards *Limnas chrysippus* and the variety *lycia* towards *esebria*. That this latter is the case I am led to believe by the fact that in Mashonaland only the type-form occurs and there *esebria* is also absent, whereas along the South-east Coast where the latter is plentiful, *lycia* occurs, and when I met with it in Durban I was struck with its resemblance on the wing to the whiter specimens of *esebria*, though this is not so apparent in the cabinet."

"*Malvern, Natal; Feb.* 21, 1897.—The case of *H. misippus* is however more puzzling than the *Euralias* which mimic *Amauris*. The *inaria* form of the female is

often cited as a mimic of *L. chrysippus*, var. *klugii*. Now this is by far the commoner form of the female *misippus* in S. Africa, whereas *klugii* appears to be extremely rare, in fact the single specimen recorded by Trimen is the only one I know of. How then can it be said to be mimicked by *inaria?* Again, *misippus* is recorded in several places in South America, where I believe *chrysippus* does not occur. It seems to require further investigation."

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—I certainly think that I have more frequently seen *Hypolimnas misippus* (female) in company with *L. chrysippus* than with its own male. The latter is fond of haunting the tops of kopjes in company with various species of *Precis* (which always occur in such localities), but I have never seen the female do so, neither does *chrysippus*."

The range of the forms of *encedon* corresponds remarkably well with the forms of *chrysippus*. Mr. Marshall states above that the *klugii*-like form *dorca* is extremely rare in the south where *klugii* is absent. Passing northward on the east side of the continent it gradually increases in proportionate numbers till it preponderates over *encedon* where *klugii* preponderates over *chrysippus*. On the West Coast all forms seem to occur, but recently the white-hind-winged *alcippina* (Plate XV, fig. 7) has been found there in greater numbers than elsewhere. (Aurivillius, Rhopalocera Ethiopica, Stockholm, 1898, pp. 533, 534; Poulton, Proc. Linn. Soc. Lond., 113th Session, p. 6, Report of Meeting Dec. 20, 1900, where however the name *encedon* is erroneously printed *unicolor*.) The distribution of the Lycænid mimic corresponds equally well, *marshalli* with *chrysippus* in the south (Mashonaland), *dohertyi* with the predominant *klugii* in British East Africa. *H. misippus* ♀ shows upon the whole an almost complete lack of correspondence, for *inaria* is common nearly everywhere, while *klugii* is confined to the range described on p. 476. In British East Africa, however, *misippus* ♀ corresponds well with the two forms of its model; while on the west, where *alcippus* is the only form, the want of geographical coincidence is most striking, for the *inaria* form is relatively abundant, while neither in it nor in the type-form, so far as I am aware, is there any special tendency towards the development of white in the hind-wings. It is a striking fact that the Acræine mimic should exhibit so close a coincidence with the geographical range of its Danaine

model, while the Nymphaline mimic shows such a marked want of correspondence. The comparison may help naturalists to realize the great importance of Müllerian mimicry and the searching selective process which has brought it about.

I have for many years attributed this want of correspondence between the commonest mimic of *chrysippus* and its model, to the wide-ranging powers of the former butterfly and its great tendency to wander, combined with some special protection which there is reason to believe it possesses, rendering its resemblance synaposematic rather than pseudaposematic. There are in the Hope Department three females (two of them *inaria*) and two males of *H. misippus* captured out of a swarm through which the ship *Winefred* passed in May 1893, when she was on the Atlantic over 500 miles from land (Ent. Record., vol. xii, No. 11, p. 315). The Müllerian resemblance of *misippus* ♀ to *chrysippus* was suggested by the present writer at the meeting of the American Association for the Advancement of Science in 1897 (see vol. xlvi, p. 242, where arguments in support of this conclusion may be found). Extracts on this subject from Mr. Marshall's letters are printed below:—

"*Malvern, Natal; Oct.* 7, 1897.—I fear I cannot at present accept your suggestion that *Hypolimnas misippus* is itself protected. I may be wrong, but in these matters I depend more than anything on the habits and actions of the insects as I have seen them when undisturbed and when frightened. There is to my mind a radical difference between mimics and their models (as opposed to convergent forms) which is often very difficult to define. There is also a structural difference which appeals to me, so that I believe I could almost tell one from the other with my eyes shut merely by the feel of it in the net. To give an instance: when on a short holiday trip to the rich Mazoe Valley in December 1894, I started out on Christmas Day with the set purpose of catching something "good" to commemorate the occasion. While strolling along the narrow belt of thick bush which there fringes the river, I saw flying leisurely in front of me what I took to be a very small and brightly-coloured specimen of *Limnas chrysippus*. I coveted it, and a few seconds later it was in my net, through the folds of which I could but indistinctly see it, so that I was still deceived. But no sooner

had my finger and thumb met across its thorax than my heart beat high with that keen excitement that every ardent entomologist feels when he has found some unexpected treasure—for I knew I had got a new mimic of *chrysippus!* A short inspection showed it to be a new Lycænid—a *Mimacræa* (since named *M. marshalli*, Trimen). On the other hand, when I caught my first specimen of *Aletis* here in Malvern in March 1893, I remember it puzzled me much, for I felt sure it was not a mimic of *chrysippus*, and yet I could not understand the reason of the colouring, for I was then unaware of Müller's theory.

"To return to *misippus*, although I admit it is a somewhat difficult case, yet the fact that it has elected to mimic what I take to be the hardiest and best-protected butterfly in Africa, combined with the general adaptability to varying conditions which one would expect it to share with its nearest allies the Junonias, must I fancy go a long way towards explaining its wide range and comparatively large numbers. There is another factor that must not be overlooked, and that is that through a considerable portion of its range in South-east Africa at all events it is the only butterfly which shows mimicry of *chrysippus*. This is particularly noticeable on the rolling grass veldt of the inland plateaux where *chrysippus* is particularly abundant.

"I think your idea as to the latter insect having originated in Africa is excellent and in every way most probable."

"*Salisbury, March* 6–10, 1898.—The facts that you mention with regard to *Hypolimnas* are certainly very curious, and would seem to be only explicable by presuming the species you mention to be protected. But in the case of *Hypolimnas misippus*, after reviewing the general habits and attitude of the female, I cannot bring myself to believe that it is anything but a true Batesian mimic. Might it not be a similar case to that of the genus *Papilio*, in which we have the distinctly protected and distasteful *P. coon* and at the same time the clearly mimetic *P. cenea?*"

D. *A Study of Mimetic Forms may enable us to reconstruct the Lost Stages through which the Older Model has passed.*

If *klugii* has been derived from *chrysippus* we should expect to find traces of the markings of the latter upon the wings of the former. And as a matter of fact faint

indications of the white sub-apical bar of *chrysippus* can be detected in *klugii*, especially at the points on the costa and the hind margin which the two ends of the bar would have reached. Very faint traces of the course of the bar between these two points can be made out in certain individuals (Plate XV, fig. 1), while occasionally they are very distinct, especially upon the under-side (Plate XV, fig. 1*a*). Looking at these two figures, and comparing them with Figs. 1 and 1*a* on Plate XIV, it is impossible to resist the conclusion that we see before us the vestiges of a fading character and not the rudiments of a developing one. It is interesting to note that one of the slightly intermediate varieties of *klugii* here represented (viz. Fig. 1, Plate XV) was an individual captured by Mr. and Mrs. Hinde at Machakos Road, and that three or four others of the same set showed similar tendencies. It may be that the unfavourable conditions (see pp. 473, 474), although unable to change one form into another, nevertheless administered a shock which caused a slight reversion towards the ancestral type in some individuals.

The three great mimics of both forms of *chrysippus*, the female of the Nymphaline, *Hypolimnas misippus* with its *inaria* form mimicking *klugii*; the Acræine, *A. encedon* * with its *klugii*-like form *daira*; the Lycænid *Mimacræa marshalli* with what I believe to be merely its *klugii*-like form *dohertyi*, all these show precisely the same thing as their model only in an exaggerated form, because the mimic *follows* its model and therefore still exhibits stages which the latter has left behind. Comparing the upper- and under-side of the *chrysippus*-like Lycænid on Plate XIV (Figs. 2 and 2*a*) with those of the *klugii*-like form on Plate XV (Figs. 2 and 2*a*), there can be no doubt that the latter developed from the former. The white bar of *marshalli* (Plate XIV) can still be distinctly traced in *dohertyi* (Plate XV), not indeed as a white bar but as a very faint paling of the ground-colour over a sub-apical area, the outline of which exactly

* The first recognition of the mimicry of *chrysippus* by *encedon*, and indeed of the existence of Müllerian mimicry in the Ethiopian Region, was first brought forward at the meeting of the British Association at Toronto in 1897 (Report, p. 689). Aurivillius (Rhop. Eth. 1898, p. 533) states that the resemblance had not been previously noticed. The account given by Aurivillius is however far more complete than that in the brief abstract here referred to, and is also accompanied by illustrations.

corresponds to the bar itself. The comparison to a pseudomorph suggests itself; the bar is indeed absent but its shape is there. The case of the Acræine mimic is still clearer, Figs. 3 and 3*a* on Plate XIV bearing the same relationship as that above described in *marshalli-doherty*, to Figs. 3 and 3*a* on Plate XV. The same "pseudomorph" of the white bar can be seen in the latter, while in Figs. 4, 5, and 6, on Plate XV, some by no means uncommon intermediate varieties between *encedon* and *daira* are represented. Fig. 7 shows the form *alcippina* which resembles *alcippus*, the white-hind-winged *chrysippus*.

When a geologist finds a recognizable fragment of one rock included in a stratum of another, he is usually safe in inferring that the latter is the younger. With equal confidence the zoologist may conclude that the mimicking species is younger than the species it mimics. The latter must have been in existence before the former attained a resemblance to it. From this point of view the comparison between *chrysippus-klugii* and their mimics is of intense interest. *Chrysippus* and *klugii* are now well defined the one from the other, and it is probably impossible or at least extremely difficult to get a series of intermediate forms between them. If we had not the mimics we might well believe that *klugii* arose ready-made from *chrysippus* by a process of discontinuous or transilient evolution. But two of the younger mimics are very common and widespread, and both *misippus-inaria* and *encedon-daira* present us with abundant varieties showing every grade of transition from the one form to the other. Of the Lycænid less can be said. It is still extremely rare (see pp. 472, 473) and at present only known in two widely-separated areas. But even in it the gap *marshalli-doherty* has been shown above to be much less wide than that of *chrysippus-klugii*. We are led to believe from this comparison that in some earlier age the two forms of the Danaine model existed in the stage now reached by their commonest mimics, and, like these, were connected by a series of abundant intermediate varieties which have since been obliterated by selection.

E. *Amauris echeria-like Group: Marked Secondary Resemblances between the Forms mimicking echeria.*

This species of *Amauris*, with its very characteristic rectangular buff patch on the hind-wing and buff or white-

spotted fore-wing, is the dominant Danaine of South Africa, and extends in considerable abundance right up the east and east central parts of the continent well into British East Africa. It is a centre of convergence for several *Nymphalinæ* and *Papilioninæ* in the same district.

An interesting group, captured by Mr. Marshall at Malvern, on March 25, 1897, consists of the following species:—

*Amauris echeria*, var. *albimaculata* ♂.
2 *Euralia mima* ♀.
*Papilio cenea* ♀, *cenea*-form, with white spots on fore-wing, like the var. *albimaculata* of *A. echeria*.
*Papilio leonidas*, var. *brasidas*.

The last-named *Papilio* is a somewhat outlying member of the group, being separated from the others by the patch on the hind-wing, which is white with a faint greenish tinge, instead of buff. The general arrangement of the light markings on the black ground is however similar, and Mr. Trimen states that "it was in the habit of settling precisely in the way affected by the *Amauris*, viz. on a projecting leaf or twig, with the wings closed and hanging downward, and in this exposed position remaining motionless for a considerable time" ("South African Butterflies," vol. iii, 1889, p. 216). In two points, viz. size, and contour of the wings, it is more like the Danaine model than any of the other above-mentioned species.

The most interesting point about the group as a whole is, however, the undoubted secondary resemblance between the species which primarily resemble the *Amauris*. The secondary resemblance is, moreover, even stronger between *P. cenea* and the *Euralia* than between either of these and *P. brasidas*, that is to say, the species exhibiting a closer primary mimicry also exhibit a closer secondary mimicry. This fact suggests that the secondary resemblance is of permanent value and not a mere phase which will ultimately be lost in the primary resemblance. Mr. Marshall informs me that these secondary mimetic resemblances are still more marked upon the wing, so that a naturalist may often be sure that he sees before him a mimic of *echeria* or of a black-and-white *Amauris*, but cannot in any way distinguish the mimic itself as *Papilio*, *Pseudacræa*, *Hypolimnas*, etc.

The points in which the mimics of *A. echeria* converge together and diverge from their primary model are as follows:—

(1) Size: They are much larger than their primary model. *Brasidas* is in this respect intermediate.

(2) Scalloped outline of hind-wing; feebly marked in *brasidas*. Slight indications of scalloping are intensified in *echeria* by the fringe being marked by two white spots in each of the shallow concavities. This is only distinct in some individuals, apparently chiefly from the northern part of the range. The marked concavities of the mimics are also intensified by whiteness.

(3) Elongated oval shape of largest spot in fore-wing, viz. the spot below the cell, while that of the model is nearly circular. The long axis of the oval spot furthermore assumes the same direction in each of the three species, while that of *echeria* is entirely different.

(4) The *much* greater prominence in all three mimics of the sub-marginal row of white spots on the upper-side of both wings.

(5) Strongly-marked black internervular rays pass inwards from the margin of the hind-wing of *Euralia* and invade the periphery of the ochreous patch, uniting with the black veins to make up a pattern of radiating dark lines. The radiate appearance of the under-side is even more prominent than that of the upper-side. *Papilio cenea* ♀ is very similar, except that the upper surface exhibits only faint indications of the character (which however is strongly marked in the *hippocoon* form resembling *Amauris dominicanus*).*

Some of these differences between mimics as a whole

* In this respect, viz. the prominent development of internervular rays on both surfaces of the hind-wing, the *hippocoon* form of the Western *P. merope* presents a far closer resemblance to its co-mimic *Euralia anthedon* than to the primary model *Amauris niavius*, and similarly the *hippocoon* form of the Southern and Eastern *cenea* to *Euralia wahlbergi* than to *Amauris dominicanus*. Not only is there the conspicuous radiate appearance wanting in the Danaine model, but the white centre of the upper surface of the wings deepens gradually at its margin into black in both Papilio and Nymphalid, while the margin of the corresponding white area in the Danaine exhibits an extremely sharp and abrupt transition into black.

and their primary model are less pronounced in the northern part of the range, in British East Africa, where the *Amauris* is often larger and commonly possesses far more distinct sub-marginal spots on the upper-side. It is interesting to compare other mimics of *echeria* with the members of the group captured by Mr. Marshall at Malvern on March 25, 1897.

The female of *Pseudacræa tarquinia* is a poorer mimic of *echeria* than *Euralia mima* and *Papilio cenea* ♀, although upon the wing the resemblance is doubtless strong. In size it closely approaches the model: it has a slightly-scalloped border, and an irregular oval spot with a direction similar to that of the other mimics; the marginal spots are small as in the southern *echeria*. On the under-side of the hind-wing is a basal brown patch with conspicuous round black spots as in many Planemas. In the development of internervular black stripes invading the squarish ochreous patch on the hind-wing it resembles *Euralia* and diverges from the Danaine model.

The female of *Papilio jacksoni*, in the shape and direction of the spot below the cell on the upper-side of the fore-wing, far more closely resembles *echeria* than any other mimic I have seen. On the other hand, the hind-wing is deeply scalloped, the effect being much intensified by white-margined concavities, the sub-marginal spots are as a whole larger than those of any other mimic, while the under-surface of the hind-wing exhibits very little approach towards the *Amauris*, retaining the basal, black-spotted brown triangle of the male, that well-known synaposeme and pseudaposeme of many Ethiopian Papilios, Planemas, Acræas, Elymnias, Pseudacræas, etc., unknown in the Ethiopian *Danainæ*. Thus, in addition to its primary mimicry of *echeria*, var. *albimaculata*, *jacksoni* manifests secondary mimetic resemblance to the former group of Rhopalocera, especially the Planemas, and also an approach to other mimics of *echeria* in its conspicuous sub-marginal spots and deeply-scalloped border. The general effect of the spotting of the fore-wing is also more like that of *P. cenea*, and even of *Euralia mima*, than its primary model.

The female of the south-eastern *Papilio echerioides* is very similar to that of *jacksoni*, but the spot below the cell of the fore-wing is oval and in shape and direction more nearly resembles that of *Papilio cenea*.

F. *The Origin of the black-marked, golden-brown Triangle at the base of the Hind-Wing under-side in many Ethiopian Butterflies.*

Mr. Roland Trimen, F.R.S., considers that the black-marked, triangular, golden-brown basal patch on the under-side of the hind-wing of the female *P. cynorta* which mimics *Planema gea*, and *P. echerioides* [and we may now add *P. jacksoni*] "points to the inference that mimicry of the Planema group was in both these *Papiliones* the earlier tendency, and has only more recently been diverted in the direction of *Amauris* in the case of the Southern species"; for "this character is in the ♂s of *cynorta* and *echerioides* even more developed than in the ♀s, and is in direct mimicry of the *Planema*" ("South African Butterflies," vol. iii, 1889, p. 258). But if in the female of *cynorta*, which is admitted to be an excellent *Planema* mimic, this very character is reduced, how can it be believed that its greater development in the male is a case of direct *Planema* mimicry, seeing that in every other respect this sex, if a mimic at all, is a most imperfect one?

A comparison of the Papilios and Planemas with the most remarkable development of this warning character at the base of the under-side of the hind-wing renders it probable that in this respect the latter have acted as Müllerian mimics rather than models. The character is far more highly developed and specialized in a section of Ethiopian Papilios than in any of the Planemas: it also appears in forms which are unknown, and accompanied by other warning characters which are also unknown in the Planemas; it reaches its highest development in species which do not mimic Planemas. It is also probable that the conspicuous, sharply-outlined white band of the male *echerioides, cynorta*, etc., nearly alike on both upper- and under-sides, is a warning character peculiar to this group of tailless Ethiopian Papilios. In the most strongly-marked species, with sexes nearly alike (*zenobia, cyprœofila*, etc.), the outer margin of the band on the fore-wing is coarsely serrated in a very characteristic manner on both surfaces. Furthermore (in *cyprœofila, gallienus*, etc.), another warning character of great interest is added in the row of large conspicuous marginal white spots on both surfaces of the hind-wing and smaller ones on the fore-wing. In this respect this group of Papilios presents an exact

negative of the positive form of synaposeme characteristic of the Pierine genus *Mylothris*. Thus very striking warning characters are peculiar to this section of Papilios, the fifth or Zenobia Group of Aurivillius; and, furthermore, the character we are specially considering, the black-marked basal patch of the under-side of the hind-wing, assumes a form which is unknown in *Planema*, being traversed by blackened veins and broader black internervular lines. In the species of *Papilio* last mentioned there are no spots upon the brown triangle, only these strongly-marked radiating lines. In *zenobia* and still more in the male *cynorta* a few spots are added by modification of some of the other markings, and it is probable that this slight change is a late diaposematic response to *Planema*, made after the latter had gained the golden-brown triangle in Müllerian mimicry of these dominant Papilios.

Another important point is the fact that the golden-brown triangle is *larger* in the females than the males of *cypræofila* and *zenobia* which do not mimic Planemas, *smaller*, as has already been pointed out, in the females of the species which strongly exhibit this Müllerian approach to either *Planema* or *Amauris*.

It must also be remembered that Papilios may be excessively unpalatable to insect-eating animals as a whole. Thus Mr. Frank Finn concludes that *P. aristolochiæ* is more distasteful to birds than *Danainæ*, *Acræa violæ*, and *Delias eucharis* (Journ. Asiat. Soc. Beng., lxvii, pt. ii, 1897, p. 614).

The facts and arguments set forth above render it probable (1) that the golden-brown triangular patch first arose in the Zenobia Group of Ethiopian Papilios; (2) that it was later reproduced on a smaller scale by the Acræine genus *Planema*, the Acræine round black spots contrasting with the ground-colour in place of the radiating black lines of the *Papilio;* (3) that, later still, other widely-separated genera reproduced the character in the form it had assumed in *Planema*, e. g. *Pseudacræa*, *Elymnias*, etc., while a reciprocal (diaposematic) tendency (see p. 426) to approach the *Planema* form is seen in certain species of the Zenobia Group of Papilios. Several species of the group have females mimicking Acræines or Danaines. In the three of these which were examined the males exhibited the above-described diaposematic tendency, while the females possessed a greatly-reduced but otherwise similar triangular patch.

Hence this characteristic widespread Ethiopian synaposeme and pseudaposeme has probably originated in a diaposematic fusion of the triangular golden-brown patch of the Zenobia Group of Papilios with the scattered circular black spots which are characteristic of Ethiopian Acræas. I have made much use of Aurivillius' admirable "Rhopalocera Ethiopica" in this section which is devoted to the discussion of an under-side synaposeme, although the distinguished author himself maintains that mimetic resemblance is almost confined to the upper-side of butterflies' wings—a very strange conclusion (*loc. cit.*, p. 535).

G. *Compound Group containing Representatives of all the three previously described. Species probably entering two Groups.*

The groups described above fly together, and thus represent in a compound group the chief types of butterfly coloration which a young insect-eating animal of South and Eastern Africa requires to learn, by a trial of one or more representatives. The following members of the three groups were captured by Mr. D. Chaplin at Berea, a suburb of Durban, on April 5, 1896, and are now in the Hope Department.

| Black-and-White Group. | *Echeria*-like Group. |
|---|---|
| *Amauris ochlea.* | *Amauris echeria*, var. *albimaculata.* |
| *Planema aganice* ♀. | *Euralia mima.* |

*Chrysippus*-like Group.

*Limnas chrysippus* ♂.
2 *Hypolimnas misippus* ♂, ♀ type-form.
2 *Acræa petræa* ♂ ♀.
2 *Acræa encedon*, type-form and var. *Lycia.*

That the same species may produce two or more forms entering as many groups is well known, but, as a rule, such polymorphism is confined to the female sex. In the polymorphism of *Acræa encedon*, however (see pp. 483, 484), we have a case in which both sexes are present in the various forms, and although the relative numbers of the forms are very different and certain of them may perhaps be absent from a district, I know of no case in

which one alone is found in any part of the total range of the species. Hence the polymorphism, although partially a distributional phenomenon, is not entirely so. On the other hand, I know of no example among the Lepidoptera in which a species is at the same season divided into two sub-equal sections throughout its range, each containing both males and females, and each section mimicking a very different model. Among Diptera, the European *Volucella bombylans* and its form *mystacea* supply good examples; and now Mr. Marshall has collected evidence which makes it in the highest degree probable that the Lepidoptera are not without such cases. He brings convincing support for the belief that *Euralia wahlbergi* and *E. mima* are the two forms of a single species. It is greatly to be hoped that Mr. Marshall may be as successful in establishing this interesting and unique case, as he has been in the marvellous seasonal transformation of *Precis*. His evidence is set forth in the following quotations from his letters:—

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—In my own mind I am pretty well convinced that *Euralia mima* and *wahlbergi* are one and the same species which has developed two mimetic forms as in *Papilio cenea*, but that in this case both sexes are concerned. My reasons for so thinking are that they have been taken *in coitu* several times, that specimens occur presenting intermediate coloration, and also that the two forms are always found together whenever they are met with in any number. I have not often been fortunate enough to see these congregations, but I remember seeing some thirty or forty specimens, comprising about equal numbers of each form, collected together on the side of a steep shady kraantz along the Palmiet River. Mr. A. D. Miller, who has collected for many years in Durban, tells me this is by no means uncommon, and that they congregate particularly in the afternoon when going to roost. Mr. C. N. Barker tells me that some years ago he came across a large number of both forms on a large tree on which they had evidently bred, for many of them had only just emerged, and some had not their wings fully developed. This shows that they are also associated in their earlier stages."

About the time when this passage was written Mr. Marshall presented to the Hope Department a set of eight individuals of these Euralias, viz. four of *E. mima* (2 ♂,

2 ♀), and four of *E. wahlbergi* (3 ♂, 1 ♀), which he had captured on the Umbilo River, near Durban, Natal, on June 28, 1897. His account of the habits of this little company is given below.

"*Malvern, Natal; Oct.* 7, 1897.—The specimens of *Euralia mima* and *wahlbergi* were captured going to roost together on a small clump of ferns under a steep kraantz between 3 and 4 p.m. Although disturbed a good many times in my efforts to catch them, they always returned after some minutes. There were two others which were too tattered to keep, and two more that I failed to catch."

If Mr. Marshall's conclusion be established, it follows that the corresponding and closely-allied mimetic West African forms *Euralia anthedon* and *E. dubia*, connected like *wahlbergi* and *mima* by intermediate varieties, are similarly the dimorphic forms of a single species.

H. *Groups of Synaposematic Acræas captured at the same Place and Time.*

Professor Meldola first suggested the use of Fritz Müller's principle to explain "the prevalence of one type of marking and colouring throughout immense numbers of species in protected groups, such as the tawny species of *Danais*, the barred *Heliconias*, the blue-black *Euplœas*, and the fulvous *Acræas*" (Ann. and Mag. Nat. Hist., ser. 5, vol. x, 1882, p. 425). As an example of Müllerian mimicry in the last-named group, I was anxious to obtain convergent species captured in one place and at one time. Mr. Marshall very kindly obtained two such groups for me. The first was captured by him on Dec. 31, 1898, at Salisbury, and contains the following species:—

6 *Acræa doubledayi*, var. *axina*, 4 ♂ 2 ♀ (♂ Fig. 1, ♀ Fig. 2, Plate XVI).

4 *Acræa caldarena*, 3 ♂ 1 ♀ (♂ Fig. 3, ♀ Fig. 4, Plate XVI).

4 *Acræa nohara*, var. *halali*, 2 ♂ 2 ♀ (♂ Fig. 5, ♀ Fig. 6, Plate XVI).

2 *Acræa violarum*, var. *asema*, 2 ♀ (Fig. 9, Plate XVI).

2 *Acræa rahira*, 1 ♂ 1 ♀ (♂ Fig. 7, ♀ Fig. 8, Plate XVI).

All these species are of approximately the same size and shape of wing, colour, and pattern, *rahira* being furthest

removed from the average appearance of the group, while *caldarena* is an outlying member in one respect only, viz. the pronounced apical black patch on the fore-wing. The brightly-coloured males and the brightest of the females of all these species would closely resemble each other on the wing, including the male of *violarum*, which was not captured on that particular day; and similarly a uniform effect would be produced by the darker females. The under-sides of all species except *rahira* are superficially alike. The strong superficial resemblance is well shown in Figs. 1 to 9 on Plate XVI.

A second group was captured at Salisbury on Jan. 7, 1899, and contains the two following species:—

2 *Acræa anemosa* ♂ ♀ (♀ in Plate XVI, fig. 10).
2 „ *natalica* ♀ (Plate XVI, fig. 11).

These large Acræas are obviously very different in the details of coloration, but the positions in which the black marking of the upper surface are massed on the fulvous ground-colour are almost exactly the same, the only marked difference being the presence of numerous black spots in the first-named species which are almost absent in the second. Mr. Trimen speaks of *anemosa* as "in habit and general colouring very near *natalica*" (*loc. cit.*, vol. i, p. 156). The under-sides are far less alike, but there can be no doubt about synaposematic convergence having occurred. It is probable that the approach has been chiefly, perhaps entirely, on the side of *natalica*, which has adjusted markings of a type usual among Ethiopian *Acræinæ* in such a manner as to produce superficial similarity to *anemosa*, an *Acræa* in which a very remarkable and unusual appearance is the warning sign of exceptional defence against insect-eating animals (see p. 413).

Mr. Marshall informs me that the two species are very similar upon the wing, and that the resemblance is much closer in the case of the female *natalica* than the male, thus following the rule in mimicry, and confirming still further the opinion expressed above that the approach has been from the side of *natalica*.

### I. *Mimetic Species of South African Lycænidæ and Hesperidæ captured with their Models.*

Exclusive of *Mimacræa marshalli* and its form *dohertyi*

which were discussed in relation to their models *chrysippus* and *klugii*, the groups containing *Lycænidæ* or *Hesperidæ* are considered below.

A group of the smaller Acræas with a single mimetic Lycænid was captured at Salisbury on Sept. 28, 1900. It contains the following species :—

2 *Acræa violarum*, var. *asema* ♂.
1 „ *doubledayi*, var. *axina* ♂.
1 „ *induna* ♂.
1 *Catochrysops mashuna* ♂ (figure of ♀ on Plate XIV, fig. 5).

*A. induna* falls into the first-mentioned group of small Acræas, resembling *caldarena* in the possession of a black apical patch to the fore-wing. The strong development of black spots upon an ochreous ground on the under-side of the Lycænid is doubtless mimetic in the position of rest, especially when in the company of Acræas or in places where they are likely to be found. Mr. Marshall informed Mr. Trimen "that on October 20, 1894, he saw two of this *Lycæna* sleeping on the end of a stem of dry grass among a number of *Acræa nohara* and *A. caldarena*, and was struck with the general similarity of their under-side to that of the Acræas; he also noticed that in the attitude of repose the fore-wings of the *Lycæna* were well depressed between the hind-wings, giving the insect the elongate outline of an *Acræa*" (Trans. Ent. Soc. Lond., 1898, p. 6). Mr. Trimen also suggests that the heavy black spotting of *L.* (*C*) *gigantea* and *L.* (*C*) *perpulchra* (Trim.) [=*peculiaris*, Rog.] is of the same significance, although the ground-colour is not *Acræa*-like in these species.

A paragraph from one of Mr. Marshall's letters is quoted below.

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—The under-side of the *Acræa*-like Lycænid *L. mashuna* is ochreous yellow with large black spots, but I did not realize its resemblance to an *Acræa* until I saw them roosting together. The mimicry, however, is in a very incipient stage, for the yellow under-side fades somewhat rapidly, thus much lessening the resemblance; and, as it does not occur in its near allies *L. hypolcuca* and the fine *L. gigantea*, it is clearly a recently-acquired character."

In another group captured at Umtali, 3700 feet, in December 1900, the Acræas are only represented by a single

species, and that not specially suitable as a model for the other members. The great interest of the assemblage is the presence of a rare Hesperid, *A. tettensis*, in which black spots and a pale pinkish tinge on the under-side of the hind-wings appear to indicate strongly-marked mimicry of Acræas on a line along which the above-named Lycænids have advanced to a greater distance. In another respect, however, viz. the strongly-marked black-and-white margin of the hind-wing under-side, the Hesperid is a much closer mimic of a general *Acræa* type. Mr. Trimen also speaks of the spotting and tinting of the under-side of both wings of this species as very peculiar and strongly recalling the aspect of some of the smaller Acræas (*loc. cit.*, vol. iii, p. 338).

I have received from Mr. Marshall the following references to the two Hesperids in the list of species making up this group :—

"*Salisbury, Jan.* 11, 1901.—I have recently obtained at Umtali another Hesperid, the very rare *Abantis tettensis*, showing strong Acræoid coloration on the under-side, which I will send you together with a *Kedestes*, which is of interest as it shows the incipient stages of such mimicry."

"*Salisbury, Sept.* 27, 1901.—I have never seen *Abantis tettensis* with its wings closed over its back ; all that I have captured rested with wings expanded horizontally. Indeed I cannot at the moment recollect ever seeing any *Abantis* settle with vertical wings. I think it is highly probable that *tettensis* would sleep in that position, but under the circumstances I should not like to assume it as a fact without actually seeing it."

The group is as follows :—

3 *Acræa encedon*, type-form.
2 *Catochrysops peculiaris* (Plate XIV, fig. 4).
2 *Abantis tettensis* ( „ „ „ 6).
1 *Kedestes macomo*, var. ( „ „ „ 7).

In the latter Hesperid the brilliant ochreous under-side affords an effective background for the small but distinct black spots on the under surface of both wings. The general effect is somewhat *Acræa*-like, but the tint of the under-side of most smaller Acræas is pinkish when they are fresh.

A more perfect Hesperid mimic is seen in the rare *Baoris netopha*, of which a female (Fig. 13, Plate XVI) was

captured by Mr. Marshall at Salisbury on April 6, 1898, together with a male of *Acræa doubledayi*, var. *axina* (Fig. 12, Plate XVI), which is one of the many smaller Acræas, to which it bears a somewhat generalized resemblance on the under-side of its wings in the natural position of rest, which is nearly but not quite represented in Fig. 13 (see the description of the Plate). Mr. Marshall has sent the following account of the attitude:—

"*Salisbury, Feb.* 12, 1899.—The *Baoris netopha* rest with closed wings, and the fore-wings pressed well within the hind-wings so as to hide the white spots; they then look much more *Acræa*-like."

The curious reticulate under surface of the hind wings of the isolated and remarkable Hesperid *Cyclopides willemi* is mimetic of the probably distasteful *Alæna nyassæ*, which possesses a somewhat similar but much coarser reticulation. Mr. Marshall states that the resemblance is much enhanced in the resting attitude of both species by the concealment of the fore-wings, with the exception of the apex, within the hind. Both species frequent the same localities, and both rest upon grass-stems. One of each species was captured at Salisbury on Feb. 23, 1901, and another similar pair on March 3, 1901.

In thus bringing together Mr. Marshall's examples of mimicry in *Hesperidæ*, it is appropriate to include the following interesting case of mimicry on the part of a Hesperid for a Danaine larva.

"*Salisbury, March* 10, 1898.—The larva of the large 'skipper' *Rhopalocampta forestan* possesses a colouring wonderfully similar to that of *L. chrysippus*, though it lacks the filaments. I only know the larvæ of three other species of *Hesperidæ* and they are all green; moreover, they form shelters for themselves, and never come out to feed except after dusk; whereas, although *forestan* also forms a shelter, yet it frequently comes out and feeds in broad daylight, when it is a very conspicuous object."

The upper-side of *Alæna nyassæ* appears to fit in with the strong combination of black-and-white Ethiopian butterflies belonging to the *Danainæ* and *Acræinæ* and their Batesian and Müllerian mimics. Among the smaller of the latter *Neptis agatha* is probably to be placed, and this species is on the wing with the much smaller Lycænid. Thus Mr. Marshall has sent to the Hope Department specimens of the *Neptis* captured at Salisbury on March

19 and May 1, 1898, and of the *Alæna* taken on March 20 and April 3 of the same year.

It occurred to me that *Castalius calice* might also belong to the same group, but Mr. Marshall points out, in the passage quoted below, that its habits do not support this view.

"*Salisbury, Jan.* 8, 1899.—I should very much doubt whether *Castalius calice* is convergent with or even a mimic of *Alæna nyassæ*. Their habits and stations are very different, and moreover *C. calice* (of which I believe *C. melæna* will prove to be the summer form) is common in Natal and the Transvaal, where *A. nyassæ* does not occur. I should not regard *C. calice* as an unpalatable species, and its colouring is by no means conspicuous owing to its small size: it is an active little insect resembling *T. plinius, Lycænesthes*, and other arboreal *Lycænidæ* in its habits. In the intense light and shade of this climate its black-and-white markings are rather protective as it rests on the shiny leaves of its food-plant (*Zizyphus*), just as are the brilliant white under-sides of some *Iolai*. The convergence you suggest between *A. nyassæ* and *Neptis agatha* and *Nyctemera leuconoë* is highly probable, but *Amauris* and the black-and-white Acræas are all absent from the Mashona plateau, being all coast or low-veldt forms. *Alæna, Pentila*, and perhaps *Deloneura*, are in my opinion the only unpalatable South African *Lycænidæ*, and the latter is more likely to be a mimic of some day-flying moth. *Catochrysops mashuna* used to be very abundant here, but only occurring in September and October. I only saw two or three this season and always when I had no net."

Three specimens of another interesting and probably distasteful species of the same Lycænid genus *Alæna amazoula* captured on the same day, Sept. 26, 1897, as the conspicuous day-flying and probably unpalatable geometrid moth *Petovia dichroaria* were presented by Mr. Marshall to the Hope Department. Mr. Marshall had taken the group in the same locality at Malvern, Natal, and, as the passage from his letter quoted on p. 498 indicates, he believes that the resemblance is synaposematic. In the cabinet the likeness is stronger on the under than upon the upper surface, but is probably strongest of all upon the wing.

*Alæna amazoula* is a Lycænid of great interest, probably exhibiting a generalized Müllerian resemblance to the

Acræas. Although unlike any single species of *Acræa*, the likeness to this group and unlikeness to the *Lycænidæ* was sufficient to deceive Boisduval and at first Roland Trimen (Rhop. Afr. Austr., 1862–66, p. 111). In the Hope Collection also I found it had been placed among the Acræas by Professor Westwood. Its undoubted Lycænid affinities were finally established by Roland Trimen ("South African Butterflies," vol. ii, 1887, p. 222).

The above-mentioned errors as to the affinity of this aberrant Lycænid certainly support the opinion that it bears a general resemblance to the *Acræinæ*. It would be interesting to know its resting habits. With the underside exposed and the long narrow wings it would probably bear some general likeness to a very small *Acræa*. Mr. Marshall wrote concerning it as follows :—

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—*Alæna amazoula* is certainly a protected species, but I do not think it is in any way convergent towards the Acræas, for it is in no way suggestive of them on the wing, being by no means conspicuous, but rather difficult to follow. Its length of wing has been attributed to relationship with *Acræa*, but this seems open to doubt. I should prefer to consider it as a parallel development to *Acræa*, though it is worth noting that the allied genus *Lachnocnema* has also somewhat elongate wings."

"*Malvern, Oct.* 7, 1897.—The day-flying moths [*Petovia dichromaria*] captured on the same day as *Alæna amazoula* can, I think, be well regarded as convergent in coloration."

J. *Mimicry in Lycænidæ and to a less extent in Hesperidæ a Character of the Ethiopian Region. Possible Interpretation.*

The instances of mimicry in South African *Lycænidæ* recorded here, and the much larger number known in other parts of the region, especially the tropical West Coast, led me to inquire how the total number of species of this family compared with that of other parts of the world. My friend Mr. Hamilton Druce kindly made an approximate calculation of the number of described species in the two other great tropical south-extending land masses. From Australia, the Malay Archipelago, and the continental portion of the Oriental Region, over 1000 species have been described. From the Neotropical Region

about 700 species of *Thecla* have been described. In Aurivillius' catalogue of Ethiopian Rhopalocera only 582 species are recognized. The predominance of Lycænid mimicry in this latter Region is therefore in no way connected with richness in the number of species. The chief reason is certainly the existence in the Region of the sub-family *Liptenin*æ, with nearly all its species mimetic. In addition to the general Acræine appearance of *Alæna amazoula*, the *Neptis*-like *A. nyassæ* and the *chrysippus-klugii*-like *Mimacræa marshalli-dohertyi*, there is represented in the Hope Collection mimetic resemblance to *Terias* or other small Pierines on the part of *Larinopoda lircæa*, *L. tera*, *Liptena libyssa*, and *L. undularis*; to *Mylothris* by *Pentila abraxas*, *P. phidia*, and *Citrinophila erastus*; to *chrysippus* and the *chrysippus*-like *Euphædræ* and *Aletis* by *Telipna bimaculata* and *T. sanguinea*; to a general Acræine type by two or three species of *Pentila*. Many other cases of mimicry are known in the sub-family, especially towards models of the genera *Planema* and *Acræa* (see Aurivillius, *loc. cit.*, p. 530). But this remarkable group does not by any means exhaust the Ethiopian Lycænid mimics, for many species of the *Lycæninæ* mimic Acræas, *Terias* or other small Pierines and *Mylothris*. The general Acræine mimicry of species of *Catochrysops* has already been described and illustrated. Furthermore, Aurivillius considers that there is a certain amount of mimetic approach between species of *Liptenin*æ and *Lycæninæ* in which the former probably always act as models.

It is very difficult to understand this predominance of Lycænid mimicry in the Ethiopian Region, and I can only suggest the possibility that the number of feasible models of moderate and small size furnished by the abundant Acræinæ of Africa may furnish an explanation. In such cases as *Catochrysops peculiaris* and *mashuna* we see at once how naturally and easily the Lycænid under-side adapts itself to the characteristic appearance of the *Acræa* type, especially when it is further assisted by similar habits. And this suggests another equally important principle which has doubtless been fertile in bringing about Lycænid mimicry, viz. the habits of the models being such as to bring them within the range of the forms which were to mimic them. The numerous low-flying and low-settling Acræas, resting at night on grass-stems, have precisely the mode of life which is well known to be characteristic of

such a large number of *Lycænidæ*. The *Liptenina* are probably a specially-protected group, and the rarity of many of the species may be only apparent, and due to their (Müllerian) mimicry of extremely common forms for which they are constantly mistaken by naturalists.

In other parts of the world *Lycænidæ* which are evidently specially protected and extremely conspicuous are well known, such as *Talicada* of the Oriental Region and *Eumæus* of the Neotropical. These genera do not enter into synaposematic association with the best-defended butterflies of their localities, but each adopts an aposematic appearance peculiar to itself. It is probable that in the Neotropical Region, where mimicry is more striking and more fully exemplified than in any other part of the world, the habits of the Theclas are the chief obstacle to their use of this means of protection. For models of all sizes abound in this part of the world. On the other hand, in the tropical East it may be the want of a sufficient number of models of an appropriate size and habits which has acted as the barrier.

The explanation which has here been thrown out as a suggestion may also enable us to understand the cases of mimicry in Ethiopian *Hesperidæ*, a family in which such resemblances are rare. Here, however, the facts may be paralleled in the Neotropical Region where there are a few mimetic "skippers." Mimicry in this group and the want of it in the *Lycænidæ* may follow from the difference between the habits and stations of the tropical American Hesperids and Theclas.

### K. *Mimicry in the Nymphalinæ Batesian or Müllerian?*

I have had much controversy with my friend Mr. Marshall over this difficult and interesting problem, and I propose to bring forward a résumé of the arguments which seem to support the latter interpretation as opposed to the former, and then to quote his weighty objections and the interesting observations of the habits of mimetic species and genera which he has made.

1. It is of interest although probably not of extreme importance to reflect that all the great groups of unpalatable, conspicuous, and much-mimicked butterflies belong to the *Nymphalidæ*—the *Ithomiinæ*, *Danainæ*, *Heliconinæ*, and *Acræinæ*, and that the two latter are so

closely related to the *Nymphalinæ* that it is difficult to draw a line between them. The argument is not of much weight, because the intensely procryptic habits and colours of many Nymphaline genera have certainly been brought about by selection due to the great keenness and success of insect-eating animals in their pursuit. I have however suggested and brought evidence in support of the view that some of the procryptic Nymphaline species are to a certain extent unpalatable (see p. 442).

2. Mimicry in the *Nymphalinæ* does not appear in isolated forms but in all or nearly all the species of a genus. Such mimetic genera are usually very large, dominant, and wide-spread. The species themselves are also often wide-spreading, and may have an enormous range far exceeding that of the model (*Hypolimnas misippus*). Allowing for the fact that the mimetic species resemble the commonest types in the world, and so are liable to escape notice, it is probable that they are rich in individuals. In many instances we know that this is so. The more we investigate it the more does Rhopaloceran mimicry seem to be associated with dominant genera and species, rather than the feeble and hard-pressed forms which H. W. Bates presupposed in his well-known theory.

3. The dominant tendency towards mimetic resemblance in any genus cannot be explained by hereditary transmission of the mimetic form of a single parent species, or from the tendency of closely-related species to vary along nearly the same lines, because the species of a mimetic genus, as a matter of fact, mimic in many different directions. Thus *Pseudacræa* resembles *Acræa*, *Planema*, *Amauris*, and *Limnas chrysippus;* while *Hypolimnas*, including *Euralia*, is even more protean.

4. The non-mimetic species of a mimetic genus are often markedly conspicuous, exhibiting what has all the appearance of an aposematic pattern peculiar to themselves (*Hypolimnas*, *Pseudacræa*). This is also frequently true of the non-mimetic males of a species with mimetic females (*Hypolimnas*). Such aposematic patterns are especially displayed on the under-side, where procryptic colours are developed in other butterflies.

5. The converse of the last argument is also true, viz. some of the species in a genus, which is as a whole markedly conspicuous and itself mimicked, are often mimetic of quite other groups. Many instances of *Neptis*

have been given on pp. 467, 468, and mimetic species are also well known in *Limenitis, Cethosia,* etc.

6. The non-mimetic species of mimetic genera are sometimes mimicked; *e. g.* the mimicry of the *nerina* form of female *Hypolimnas bolina* by a rare Danaine in Celebes, etc. The resemblance of the upper-side of certain species of *Protogoniomorpha* to some of the larger species of *Hypolimnas* may be another instance of the same tendency.

7. The fact that mimetic species resembling some primary model nevertheless in certain respects resemble each other rather than the model. This deuterosynaposematic resemblance, as it may be called, is a very widespread phenomenon, and several striking instances of it are discussed in the present memoir (see pp. 470, 471, 485–7). It will also be shown to occur in Coleoptera (pp. 513–515).

I have given merely an outline of the chief evidence which has induced me to believe that the mimetic Nymphaline genera are to some extent specially protected, and thus have developed a beneficial synaposematic association with far better protected forms belonging to other sub-families.

This evidence has been sought and obtained under the guidance of the principles discovered by Dr. F. A. Dixey and ably presented by him in 1894–97 (Brit. Assoc. Reports, 1894, pp. 692, 693; Trans. Ent. Soc. Lond., 1894, p. 298; 1896, p. 65; 1897, p. 317). These memoirs mark one of the few important advances made in our attempt to understand the complex and difficult phenomena of mimicry. I will quote one pregnant paragraph, which it will be seen contains the essence of what I have here described as primary and secondary mimicry (see pp. 513–515, also the above paragraph 7). "Every conspicuous and distasteful form is a centre of attraction for other forms, whether edible or inedible; but in the former case (Batesian mimicry) the mimetic attraction is limited in operation, and acts only in one direction, influencing nothing but the mimic; while in the latter case (Müllerian mimicry) the mimetic attraction is unlimited and mutual, acting reciprocally in both directions, and influencing each member of the group" (Trans. Ent. Soc. Lond., 1897, pp. 324, 325).

Mr. Marshall's valuable notes on the habits of Nymphaline mimics and his discussion of the conclusions described

above, are contained in the following quotations from his letters.

"*Malvern, Natal; Feb.* 21, 1897.—As regards the Euralias my experience of them is somewhat limited, but from what I have seen of them I feel pretty sure that their coloration is due to mimicry and not to convergence. Their range seems in all cases to agree with that of the *Amauris* they resemble. In Durban *A. ochlea* is by far the scarcest of the three, and its mimics *E. deceptor* and *Pseudacraea expansa* are also very rare; further up the East Coast, however (Delagoa Bay and Beira), *ochlea* becomes one of the commonest of the genus, and the two other species are likewise much more numerous. At this place, it is true, *Euralia wahlbergi* is certainly more plentiful than *A. dominicanus*, but they are both uncommon, and all the specimens we see are practically visitors from the thick bush along the immediate coastline. (This is six miles inland.)"

* * * * *

"I may mention that in the last few years Mr. Ball has caught two *Euralia wahlbergi* [in the Karkloof Forest twenty miles N. of Maritzburg], but has never seen *Amauris dominicanus*."

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—With regard to the Euralia, etc., I must admit that I have never been fully convinced by the contention that in Batesian mimicry the mimetic species must *of necessity* be a feeble one and very few in numbers. It seems to me that it would be quite reasonable to suppose that such a mimic might well equal or even exceed in numbers the protected species, though this would of course depend entirely upon the degree of inedibility of the latter. For example, in the case of *Euralia mima* and *Amauris echeria* (probably the best-protected butterfly here), supposing they occur in equal numbers in a given area, and that certain birds by chancing to catch three or four of the former in succession were induced to prey upon butterflies with that coloration, then, from a mathematical standpoint, every alternate specimen caught by any bird would be *A. echeria*. Now I think we are quite safe in assuming that the fact that every other butterfly caught had a nauseating taste and smell would be far and away more likely to create a strong and lasting impression upon a bird's mind than the fact that every second one proved to be edible,

and would be quite sufficient to deter the bird from attempting to eat butterflies of that colour. This is from a mathematical point of view solely, but, from what I know of these two forms in life, I believe that presuming them to occur in equal numbers, a larger proportion of *echeria* would actually be captured, for *mima* is a much more shy insect, and although it has the same slow sailing flight (when undisturbed) it does not keep on the wing nearly as long as *echeria;* moreover, it is much more wary and always on the alert for danger, going off at a smart pace when frightened, and not returning to the same spot as *echeria* frequently does after being struck at: altogether it is a much more difficult insect to capture. Indeed I do not see why the mimic should not even somewhat surpass the mimicked species in numbers, without upsetting their relations to one another, provided the taste of the latter be sufficiently unpleasant, and particularly if the flavour be of a *lasting* nature."

"*Malvern, May* 14, 1897.—I feel quite satisfied that *Pseudacræa trimenii* is a mimetic and not a protected species. In spite of its larger size it looks wonderfully like *Acræa acara* on the wing, and the first few examples I caught completely took me in. Their flight is like that of all Pseudacræas and Euralias—slow and sailing—so long as they are not disturbed; but if struck at and missed they are off like a shot and do not often give one a second chance. At this particular spot (Malvern) they are a good deal commoner than *A. acara*, which is only a rare visitor. The latter is however common on the immediate coast, where *P. trimenii* is I am told pretty plentiful in good seasons."

"*Salisbury, Jan.* 12, 1901.—I quite agree with you that the resemblance between the under-sides of *Delias pandemia* and *Isbarta pandemia* is the most remarkable case yet brought forward, and one cannot but marvel how such exact similarity can have been arrived at. Although I should certainly incline to the belief that the mimicry is Müllerian, judging by the congeners of both forms, yet its very exactitude seems to be a difficulty, for although one can readily understand how in an edible and much-persecuted species the resemblance might be brought up to so high a grade, yet it is hard to understand how this could be effected in a species which is comparatively immune from attack. For it seems to be an inevitable

deduction from the theory of mimicry that a high grade of resemblance must imply excessive persecution, either now or within recent times, unless we are prepared to admit some other convergent force."

"*Salisbury, Sept.* 27, 1901.—With regard to Müllerian mimicry I quite agree that the slow flight and the bright colours of protected forms would lay them open to much experimental tasting from inexperienced birds; but the extreme toughness of their integuments (for example in the Acræas) and their great vitality seem to have been specially developed to minimize this danger. And whereas the Batesian mimic, if thus experimented with, would promptly be eaten, a Müllerian butterfly would run a very good chance of surviving its injuries and propagating its kind. Do not suppose that I in any way disbelieve in the action of Müllerian mimicry, for I certainly think it must be a very strong factor. But this point seems to me to be a real difficulty, and I should like to be able to answer it satisfactorily if it were brought up by an opponent."

L. *Miscellaneous Observations on Mimicry in South African Rhopalocera.* (G. A. K. M.)

*a. Nymphalinæ.*

"*Malvern, Natal; Feb.* 21, 1897.—I do not remember ever having seen it suggested that the female of the handsome *Charaxes xiphares* mimics *A. echeria*, but I have little doubt that such is the case. It is a fairly common species at the Karkloof, but difficult to catch, and I only took one. I believe there are more instances of mimicry in this genus, e. g. *achæmenes* and *guderiana*, of which the females are very scarce (though the male of the former is one of the commonest *Charaxes* in Mashonaland) and very differently coloured from the males, being remarkably like the common widespread *C. saturnus*. Again, some years ago I pointed out to Trimen the strong resemblance of the female of *C. whytei* to *Neptis agatha* on the wing. I hope to be able to prove before long that *Neptis* is a distasteful genus (by the way, is *Limenitis* edible?), as its appearance and habits certainly point that way."

*β. Pierinæ.*

"*Estcourt, Natal; Oct.* 15, 1896.—In Durban *Mylothris*

*agathina* was fairly abundant, and I was interested to notice the very close resemblance between it and *Belenois thysa*, though, as is the case with most mimics, the latter has a much quicker flight when disturbed. *B. thysa*, so far as my experience goes, is confined to the warm coast belt, whereas *M. agathina* is common everywhere throughout South-east Africa."

"*Malvern, March* 12, 1897.—It is curious to note that although *Nepheronia argia* was common at the Karkloof, I never saw a single specimen of *Mylothris agathina*. Mr. Ball has in his collection a very fine variety of the female of the former, which clearly mimics *Mylothris trimenia*, the upper-side of the hind-wings being lemon-yellow, and the red mark on the under-side of the fore-wings absent. This is the only one I have seen, although I took one or two females showing an approach towards it, one of which I send you."

"*Umkomaas Mouth, Natal; Sept.* 3, 1897.—I am afraid I can hardly bring myself yet to believe in Dixey's theory that the *Pierinæ* are for the most part protected. As regards our South African species, the only ones which I feel confident are protected are *Mylothris agathina*, *ruppellii*, and *trimenia*, and *Pontia hellica*. For the remainder I think we must find some other cause to account for their numbers and wide range. In *Terias* the larva possesses wonderfully assimilative colouring, and is extremely difficult to detect on the food-plant, and so far as the experience of Hutchinson and myself goes with *T. brigitta* we have never yet observed a single case of parasitism. The protective coloration and comparative freedom from parasites of the larva, and the protective seasonal colouring of the imago, would no doubt go a long way to explain their number, though I fancy there must be some other factor."

"*Salisbury, May* 1, 1899.—Query: are the black bands in the females of *Teracolus* acquired in mimicry of the common and widespread species, *Herpænia criphia?*" *

γ. *Papilioninæ.*

"*Salisbury, Dec.* 26, 1897.—*Papilio brasidas* I consider

* Dr. F. A. Dixey informs me that Professor Westwood probably suspected a relationship between the markings of *H. criphia* and *T. eris*, for he had removed a specimen of the former species from the others, and placed it next to a dry form of the *Teracolus*.

to be merely a local race of *P. leonidas*, as every one must do who has seen a long series of the two forms. I have found typical *leonidas* pretty plentifully in the low veldt of Mashonaland (Mazoe and Umfuli Rivers) and I also saw it at Delagoa Bay. I have always been struck with its marked difference in habit from the Southern *brasidas*. Its flight is strong and rapid, and it always goes straight ahead like *P. policenes* and *P. antheus*, which it somewhat resembles on the wing in spite of its very different shape. *Brasidas*, on the other hand, has a slow sailing flight, going backwards and forwards over the same ground and often frequenting one spot for days. Now there is absolutely nothing suggestive of protection in the flight of *leonidas*, none of that slow sailing movement to show off its coloration which is so characteristic of the protected *Danainæ* and *Acræinæ*. Moreover, there is no Danaine occurring south of the Zambesi which is anything like it at all, and this is very significant. I cannot therefore resist the conclusion that in this country *leonidas* is one of those unprotected species which has succeeded in the struggle for existence by its strong rapid flight, and perhaps by protection in the larval stage like *P. demodocus* and *P. corinneus*, whereas in Natal it has found it advantageous, owing to the abundance of *Amauris echeria*, to adapt its coloration in mimicry of that species by the reduction in size and number of the spots in the fore-wing and the toning down of the colour from glaucous green to greenish-white, accompanied by the marked change in its mode of flight. It does not seem to me that convergence would explain the facts, for if *leonidas* is itself protected it should exhibit throughout its range that slow flight which is the 'hall mark' of protection, which it certainly does not in Mashonaland. I believe in Central Africa it is said to mimic *T. petiverana*, and it would be most interesting to find out whether it has there assumed the Danaine flight."

"*Malvern, Feb.* 21, 1897.—I have been collecting in the Karkloof Forest some twenty miles north of Maritzburg for the last three weeks. The only *Amauris* occurring there is *echeria*, which is very common, though not this year, which is a curiously abnormal one, and as usual the typical female of *Papilio cenea* is common, the *dominicanus*-like form occurring only very rarely. But last year, so my host Mr. Jas. Ball informs me, the latter was very abundant—quite as common as the typical one, and he

caught a long series of them. It seems clear they were not immigrants from Durban, but what caused their appearance in such unusual numbers it is difficult to understand. I may mention that in the last few years Mr. Ball has caught two *E. wahlbergi* but has never seen *dominicanus*. While there, I saw six females of *P. cenea*, two of each of the three forms."

31. Warning Colours and Mimicry (almost wholly Müllerian) in South African Coleoptera. (G. A. K. M., E. B. P.)

[In the groups described below, Coleoptera play a dominant part, either making up the whole or, except in the case of the Mutilloid group, acting as models for other insects. In this one exception the chief interest centres in the Coleoptera, and therefore the group is included here. A certain number of mimetic Coleoptera will be mentioned elsewhere in other groups which have collected round various types of Hymenopterous models.

In the present section the extraordinary predominance of Müllerian associations in South African Coleoptera stands out as the most prominent conclusion.—E. B. P.]

A. *Peculiar Warning Patterns and Directive Marks in Carabidæ and Cicindelidæ.* (E. B. P., G. A. K. M.)

Some of the warning patterns of the large *Carabidæ* of the genus *Anthia* are very remarkable and effective, and their development and relationship in the different species extremely interesting.

Six illustrative examples are figured on Plate XVII. In Fig. 21 we see the ancestral appearance, the uniform black of so many large Carabids, in *Anthia massilicata*. Mr. Marshall's account of the habits of the South African members of the genus, printed on page 510, shows that such a beetle is highly conspicuous. It is no doubt an advantage, however, to gain easily-recognizable distinctive marks on the black ground of the exposed dorsal surface, and we find that the species of *Anthia* do, as a rule, possess two or more white patches upon some part of this area. The pair of elongated thoracic white patches, in *A. petersi* (Fig. 22), are borne upon the sides of a thorax which is very like that of *massilicata*, while in *A. thoracica* (Fig. 23) this part of the body is greatly widened and the white patches

become a broad oval in shape. A pair of white spots (as well as a white line towards the outer border of the posterior half of the elytra) has also arisen on the anterior part of the elytra in *A. omoplata*, var. *mellyi* (Fig. 26), and it is of deep interest to note that these spots at a little distance or when the insect is moving would resemble the entirely different thoracic spots of *thoracica* far more closely than these latter resemble the entirely homologous spots of *petersi*. The comparison of Fig. 23 with 22 and then with 26 will bear out this conclusion. Perhaps one reason for the development of the remarkable structures in which the spots are situated in *thoracica* (they are placed in the concavities of special lateral outgrowths of the thorax) may be in order to favour the synaposematic approach to an arrangement like that of *mellyi;* for by this means it is possible for the spots to attain approximately the same size and shape, and at the same time to retain an interval between them which corresponds to that obtaining in the very different position upon the elytra. The concavities exist however in a much smaller form in *A. maxillosa*, and the white markings in them are inconspicuous.

In *A. nimrod* from West Africa (Fig. 25) we see a further development of the *mellyi* pattern in the appearance of another pair of spots on the posterior region of the elytra, while in *A. sex-guttata*, from India (Fig. 24), this appearance is combined with the two spots of *thoracica*, thus building up a warning pattern of remarkable simplicity and effectiveness, being an almost exact negative of the six of dominoes. The success of the aposeme is much enhanced by the approximate equality of the shorter intervals between the spots of each pair, and the longer ones between the spots of one pair and the corresponding spots of the next. The great breadth of the thorax permits this symmetry in one direction without the development of outgrowths like those of *thoracica*, while symmetry in the other direction has been rendered possible because the middle pair of spots occupies a more posterior position on the elytra than does the corresponding pair of *nimrod* or *mellyi*. It will be seen by a glance at Figs. 23 to 25 that the addition of the spots of Fig. 23 to the thorax of Fig. 25 would produce a very inferior warning pattern as compared with that of *sex-guttata* (Fig. 24).

Mr. Marshall gives the following account (1902) of the habits of these formidable beetles :—

"The warning character of the large spots and stripes of the Anthias (Plate XVII, figs. 22–26) is well borne out by the appearance of these insects in their natural haunts. They are purely terrestrial in their habits, and prefer open, treeless country, where owing to their large size and striking coloration they are very conspicuous objects. When alarmed they adopt a very characteristic warning attitude, raising themselves high on their legs, walking in a quick jerky manner and often twisting sharply from side to side; but, as in the case of other aposematic insects, when they find these demonstrations are of no avail they endeavour to make good their escape and are then capable of running at a very fair pace. Their acid secretion is very powerful, and causes a strong stinging sensation when it touches the skin of the face or the more tender parts of the hands, and as it can be projected to a distance of some four or five feet, the insect would have to be captured with considerable caution even by an enemy which might be aware of its powers. The liquid is always ejected upwards, and the insects seem capable of controlling its direction to a limited extent. A very similar warning attitude is observable in the huge Cicindelids of the genus *Mantichora*, at least I have seen it in *M. herculeana*. The habits of this insect are very similar to those of *Anthia*, but it cannot project its protective secretion, which merely exudes when it is handled; the liquid also is not acid as in *Anthia*, but possesses a strong smell."

Mr. Marshall brings forward the very probable hypothesis that the posterior white spot or spots of the small and medium-sized *Carabidæ* are directive. The fact that they form an important element in the Mutilloid appearance of these Coleoptera is no objection whatever to this hypothesis, which is explained in detail below; for it is probable that the posterior white spots of the female *Mutillidæ* may have a similar function, directing attention to the sting. Mr. Marshall states (1902) that the abdomen is the most conspicuous part of a Mutillid (see p. 512).

"Among the diurnal *Carabidæ* in South Africa the frequent occurrence of a conspicuous white spot at the apex of the elytra is very noticeable, and there is good ground for believing that this spot is of a directive character. Unlike such insects as *Cantharidæ*, *Lycidæ*, etc., the *Carabidæ* do not appear to possess any general distastefulness, but depend for protection solely upon their

power of squirting a strongly acid liquid from behind. In the case of the largest species, such as *Anthia*, the great strength and large quantity of this liquid render it a very efficient protection; but in the smaller species my experiments and observations lead me to suppose that this is not the case, but that the utility of the secretion lies rather in the fact that it enables the insects momentarily to disconcert their enemies, and this, owing to their great activity, gives them an opportunity to escape. Under these circumstances it is evidently of importance that an attack from an enemy should be directed to the anal portion of the body in order to ensure its receiving the discharge. The anal white patch is especially noticeable in such genera as *Polyhirma* (*semisuturata*, *bennettii* [see Appendix, pp. 547, 548], *notata*, *rutata*, *macilenta*, etc.) and *Piezia* (*marshalli* and *mashuna*); it also occurs in the Cicindelid *Myrmecoptera polyhirmoides* which consorts with many of the above species. It is probable that the two white or yellow spots which are found in so many *Carabidæ* and *Cicindelidæ* (see Plate XVII, figs. 7–11, 14–19) towards the apex of the elytra have also a similar significance, that of the *Cicindelidæ* being of course mimetic (of *Mutillidæ* and *Carabidæ*)."

B. *Mutilloid Coleoptera: Cleridæ, Carabidæ, and Cicindelidæ: Primary and Secondary Synaposematic and Pseudaposematic Associations.* (E. B. P.)

When forwarding the following mimics of *Mutillidæ*, Mr. Marshall also sent a record of habits:—

"*Salisbury, Jan.* 8, 1899.—The Mutilloid type is not uncommon among *Carabidæ*, *Eccoptoptera cupricollis* being a beautiful instance of mimicry. But the markings are most developed among the *Cleridæ*, of which I have no less than twelve species all exhibiting the Mutilloid marking more or less distinctly; I expect they will be found to be parasitic on *Mutillidæ*. I have also caught a little spider which is an excellent Mutilloid mimic."

This species of Mutilloid spider and another sent later have been described by the Rev. O. Pickard-Cambridge, F.R.S., as *Prosthesima albomaculata* and *Titus lugens*. (Proc. Zool. Soc. Lond., 1901, p. 11, figs. 2, 3, Plate V.)

"*Salisbury, Feb.* 12, 1899.—The Mutilloid group is interesting though not so satisfactory from a cabinet point

of view, the resemblance being much less marked than in the field, except perhaps *Ecceptoptera* which is a splendid case, and it has caused me to hesitate more than once before venturing to handle it. At the present time I would not venture to express an opinion as to the use or significance of the colours in this group. The *Mutillidæ* of course are armed with a powerful sting, which however they are slow to use, and besides they are very hard; the red prothorax is by no means conspicuous when they are running on the ground, the abdomen being the part that catches the eye, and when hard pressed this is elevated in the air evidently as a warning. I have noticed that it is very difficult to distinguish the pattern while the insect is running, the general impression being merely that of a black body with white spots. The same applies to the *Cicindelidæ* and *Carabidæ*, which are all fast runners and most of them very difficult to distinguish *inter se* in the field at first sight. The exact resemblance of *Graphipterus antiokanus* to *Piezia selousi* is marred by the shrinkage in the former of the pygidium, which bears two white patches. *Atractonota*, despite its markings, very much resembles one of our larger black ants, especially in its manner of running. A good many other species (especially of *Cleridæ*) might also be included in the group."

The Mutilloid group of Coleoptera from Salisbury may be arranged together with their models as follows, the plan being that adopted in Plate XVII, figs. 1–12 and 14–19:—

| MUTILLIDÆ | | | | | |
|---|---|---|---|---|---|
| Mutilla purpurata ♂ Fig. 1. | M. tettensis ♀ Fig. 2. | M. cephcus ♀ Fig. 3. | M. leucopyga? ♀ Fig. 4 (Nov. 1898—Jan. 1899). | M. syconax ♀ Fig. 5. | M. horrida ♀ Fig. 6. (Nov. 1898—Jan. 1899). |
| CARABIDÆ | | | | | CLERIDÆ |
| Atractonota mulsanti Fig. 7. | Atractonota mulsanti Fig. 8. | Polyhirma ænigma Fig. 9. | Polyhirma ænigma Fig. 10 (Nov. 1898—Jan. 1899). | Ecceptoptera cupricollis Fig. 11. | Graptoclerus, sp. Fig. 12. |
| CARABIDÆ | | | CICINDELIDÆ | | |
| Graphipterus antiokanus Fig. 14 (Nov. 1898—Jan. 1899). | Piezia selousi Fig. 15. | Polyhirma bilunata, Boh. Fig. 16. (Nov. 1898—Jan. 1899). | Myrmecoptera marshalli Fig. 17. | Myrmecoptera invicta Fig. 18. | Myrmecoptera bilunata Fig. 19. |

All were captured at Salisbury, in Nov. 1898, with the exception of those specially noted as taken between Nov. 1898 and Jan. 1899.

Other species are not included in the Plate for want of space. Thus *Piezia marshalli* has a single median white spot, of which half is on one elytron and half on the other, in place of the posterior well-separated pair of spots on *P. sclousi;* and there are other species, outlying members of the group under discussion, in which the Mutilloid appearance becomes less marked, while in *Polyhirma semisuturata* it fades away altogether, although this intensely black beetle, with its white dorsal line anteriorly and white patch posteriorly, seems to be very conspicuous. The appearance of the group and the relation to the outlying species suggest a strong and very complex Müllerian association. The large *Carabidæ* of the genus *Anthia* are either entirely black or possess a peculiar synaposematic appearance, described on pp. 508–510, and figured on Plate XVII, figs. 22 to 26. The smaller *Carabidæ*, depending upon a less development of the same defence —the power of discharging a strong acid secretion— have gained an appearance, due, like that common in *Anthia*, to white markings on a black ground, but arranged so as to suggest more or less strongly the likeness of a *Mutilla*. In a single species, as Mr. Marshall points out, the resemblance is extraordinarily exact (Plate XVII, fig. 11). This may be on account of habits and a mode of life which render the likeness especially beneficial. The smallest *Carabidæ*, the *Atractonota* and *Polyhirma ænigma* (Plate XVII, figs. 7–10), in shape resemble large ants, and Mr. Marshall states above that the movements of the former aid in producing this effect. On the other hand, their white spots appear to be certainly Mutilloid or perhaps rather to resemble the Mutilloid white spots of the other unant-like *Carabidæ*. Nothing is more characteristic of a Müllerian (synaposematic) group than the complexity of likeness which is thus revealed, and yet in the light of the great hypothesis which we owe to Fritz Müller it is not difficult to understand the general principles which account for its existence.

The *Carabidæ* are a powerful, specially defended group, and it is of advantage to be recognized as belonging to the group, even though it is no doubt of still greater advantage to be mistaken, as may happen at a distance,

or on a superficial view, or during rapid movement, for the still more formidable *Mutillidæ* and ants. Hence, although the smaller species of this group resemble the latter, and the larger the former, markings are nevertheless retained which serve to connect these Coleoptera together, and enable the experience gained in an attack on one of them to be of service in preventing the waste of life in many other species. For the same reason we can understand another curious inter-relationship, viz. that there is a superficial resemblance between different genera of *Carabidæ* and between *Cicindelidæ* and *Carabidæ*. Running through, but not concealing the resemblance to the Hymenoptera, is a resemblance between the Coleopterous mimics themselves. Thus there is the likeness described by Mr. Marshall on p. 512, between *Graphipterus antiokanus* and *Piezia selousi* (compare Plate XVII, figs. 14 and 15), while the remarkable likeness of the *Cicindelidæ* to the *Carabidæ* will be at once appreciated when Figs. 17, 18 and 19 are compared with 15 and 16. The same explanation is doubtless valid. The *Cicindelidæ* are less powerful than the *Carabidæ*, but many of them emit a peculiar scent, and the genus *Tricondyla* is closely mimicked in Borneo by the Locustid *Condylodera tricondyloides*. We can well understand that it is to the advantage of *Cicindelidæ* to be one with another and more powerful set of Coleoptera, even though it may be a further and probably greater advantage to resemble the *Mutillidæ*, a resemblance which is also involved in the appearance they have gained. If this explanation be sound we shall expect also to find examples of the same kind of likeness between *Cicindelidæ* and *Carabidæ* which do not resemble these Hymenoptera. Plate XVII shows that this is undoubtedly a fact, for the all-black *Polyhirma boucardi* (Fig. 13) is seen to be strongly resembled by a Cicindelid, *Myrmecoptera polyhirmoides*, var. *mashuna* (Fig. 20), belonging to the same genus as the three white-marked species figured in the same Plate.

The *Cleridæ* everywhere tend to resemble *Mutillidæ*, but they also resemble *Cantharidæ*, and more rarely *Lycidæ* and even *Coccinellidæ*, while one genus is beautifully mimicked by a Longicorn in Borneo. The first-mentioned likeness is probably a marked example of synaposematic colouring, and I should expect that the character of the original structure and warning pattern,

rather than the parasitism which Mr. Marshall suggests, rendered resemblance to *Mutillidæ* above all other specially-defended insects particularly feasible for these Coleoptera. A good example of such mimicry is seen in Plate XVII, fig. 12, representing *Graptoclerus*, sp.

I believe that the principles discovered by F. A. Dixey, which are here employed to explain the curiously complex inter-relationships of Mr. Marshall's Mutilloid group, will hereafter be found to have an important bearing upon many superficial resemblances of mimicry and common warning colours in all countries, and in many orders of insects and probably other animals.

The double (or treble, etc.) resemblances which may be perceived one underlying the other in the appearance of a single form may be conveniently spoken of as Primary, Secondary, Tertiary, etc., Common Warning Colours (Proto-, Deutero-, Tritosynaposematic Resemblance), or as Primary, Secondary, Tertiary, etc., Mimicry (Proto-, Deutero-, Tritopseudaposematic Resemblance). Thus the resemblance of the *Atractonota* to an ant, or of *Myrmecoptera* to a Mutillid is Protosynaposematic, while their resemblance to the Carabid genera *Polyhirma, Piezia*, etc., is deutero-synaposematic. On the other hand, the resemblance of the black *Myrmecoptera* to *Polyhirma boucardi* is proto-synaposematic, or rather, synaposematic, since there appears to be no other underlying or overlying resemblance in this case.

Many examples of this kind will be found in the section on Mimicry in Lepidoptera; see especially pp. 470, 471, 485–487.

I must here again refer to Dr. F. A. Dixey's important memoirs, alluded to in greater detail on p. 502, as containing the first account and interpretation of the extremely complex inter-relationships which may exist in Müllerian associations. The principles which he laid down are here found to supply the interpretation of many puzzling and subtle relationships, not only among Lepidoptera, but also in other Orders in which the phenomena of mimicry, warning colours, etc., have been far less fully investigated.

### C. *Lycidæ as Models for other Coleoptera and Insects of many Orders.* (G. A. K. M.)

[The splendid and complex convergent group, represented on Plate XVIII, figs. 1–52, is by far the most

complete illustration hitherto known of the power of mimicry to attract forms of all kinds irrespective of affinity. It is of the deepest interest to observe that the association is almost entirely Müllerian (synaposematic). The following passages are quoted from letters written by Mr. Marshall about the time when the first consignments were sent; but the group became very much larger when the additions of later consignments were included.—E. B. P.]

*Salisbury, Jan.* 8, 1899.—The two most prominent types of colour among mimetic Coleoptera are what I call the Lycoid and Mutilloid types. Of the former I have put aside for you a series comprising fifteen species, including several species of *Lycus*, three species of Longicorns, a Reduviid bug, a fly, a wasp, an Arctiid moth, a *Mylabris*, a *Hyperacantha*, etc., and I shall be able to add more in all probability.

The Lycoid Arctiid moth is a day-flyer, but the deceptive resemblance is not good on the wing, being best shown when the moth sits, as is its wont, on the ends of grass-stems, etc., after the manner of a *Lycus;* it is perhaps even more like *Prionoccrus dimidiatus*, a Lycoid unpalatable Malacoderm which has a similar habit.

*Salisbury, Feb.* 12, 1899.—The six species of *Lycus*, the *Prionoccrus*, *Diacantha*, *Zonitis*, *Mylabris*, and *Eletica*, I proved by experiment to be distasteful to baboons and a kestrel. The Zygænid I presume to be so likewise, as it emits a strong smell; the *Telephorus* will also probably prove to be unpalatable. The four species of wasps have all got very effective stings; thus the only unprotected insects are the fly, which is an admirable mimic of one of the wasps, and the three Longicorns, though I am not quite certain about *Philagethes*. As to the *Reduvius* I do not know what to say, there are certainly some very remarkable cases of mimicry in this family. * * * *
In flight the Zygænid [*Neresympleca*, Fig. 52] is aided by its very brilliant hind-wings, and the Hymenoptera have a flight very different from, and far swifter than, that of *Lycus*.

[A complete list of the species arranged in their respective families is given below. Large as the group is it could certainly be made much larger, especially if the whole of South Africa were put under contribution. Thus an obvious addition to the Longicorn mimics is *Dyenmo-*

*nus apicalis*, which Mr. Marshall has not yet taken in Mashonaland.—E. B. P.]

Group with Lycoid Markings (Plate XVIII, figs. 1–52).

| | | |
|---|---|---|
| Coleoptera | *Copridæ* | Aphodius holubi (fig. 18). |
| | *Malacodermata* | Lycus (Merolycus) rostratus (figs. 1, 2).<br>Lycus (Acantholycus) constrictus (fig. 3).<br>Lycus ampliatus (figs. 4, 5).<br>Lycus (Lopholycus) zonatus (fig. 6).<br>Lycus (Lopholycus) haagi (figs. 7, 8).<br>Lycus (Chlamidolycus) subtrabeatus (figs. 9, 10).<br>Lycocerus mimicus (figs. 11, 12). |
| | *Melyridæ* | Prionocerus dimidiatus (fig. 13). |
| | *Phytophaga* | Pœcilomorpha fasciaticollis (fig. 14); Diacantha conifera (figs. 16, 17).<br>Peploptera zambesiana (fig. 15). |
| | *Lagriidæ* | Eutrapela sp. (fig. 19). |
| | *Cantharidæ* | Eletica rufa (figs. 20, 21); Mylabris palliata (fig. 22); Zonitis sp. (fig. 23). |
| | *Longicornia* | Amphidesmus analis (fig. 25); Philagathes lætus (figs. 26, 27).<br>Nitocris sp. (fig. 28); N. similis (fig. 30); N. ?nigricornis (fig. 29).<br>Blepisanis haroldi (fig. 24). |
| Hymenoptera | *Braconidæ* | Phanomeris sp. (figs. 44, 45); Iphiaulax bicolor (fig. 46); Bracon luctuosus (fig. 47); Bracon ?luctuosus (fig. 48). |
| | *Pompilidæ* | Pompilus morosus (fig. 36); P. capensis (fig. 37); P. diversus (fig. 38); P. vindex (fig. 39). |
| | *Crabronidæ* | Cerceris orientalis, var. (fig. 40). |
| | *Larridæ* | Notogonia crœsus (fig. 41). |
| | *Eumenidæ* | Rhynchium radiale (fig. 42); R. rubens (fig. 43). |
| Hemiptera | *Pyrrhocoridæ* | Serinetha mutilata (fig. 33). |
| | *Lygæidæ* | Lygæus furcatus (fig. 34); Oncopeltus famelicus, var. jucundus (fig. 35). |
| | *Reduviidæ* | Vitumnus miniatus (fig. 32); V. cinnabarinus (fig. 31). |
| Lepidoptera | *Arctiidæ* | Ilema elegans (fig. 50). |
| | *Zygænidæ* | Neurosymploca ochreipennis (fig. 52); Zygænid (genus ?) (fig. 51). |
| Diptera | *Asilidæ* | Xiphocerus cruciger (fig. 49). |

In the above group the beetles of the genus *Lycus* undoubtedly constitute the dominant factor towards which the other insects have converged with more or less exactness. The members of this genus are very numerous throughout S.E. Africa both in species and in individuals. They are most conspicuous insects, and the majority of them occur on flowers, though a few species are more often

to be found on the heads of grasses. In habits they are very sluggish and have a slow heavy flight; when handled they usually emit from their limbs a very strong-smelling white liquid, and they frequently feign death. The Melyrid *Prionocerus* has somewhat similar characteristics, but is found only feeding on grass seeds. Among the Phytophaga it is possible that the *Pœcilomorpha* is a Batesian mimic, for the species of this genus are nearly all more or less scarce, and moreover exhibit marked mimetic tendencies in very different directions. The *Diacantha*, to which *D. dimidiata* might also have been added, is a very plentiful insect with a nauseous smell; it causes much damage to garden plants such as cucumbers and pumpkins. The *Peploptera* is likewise abundant, frequenting acacias. All the species of Lagriadæ and Cantharidæ mentioned are flower-feeders, and are certainly protected by distasteful qualities. The significance of the colouring in the Longicorns is still a matter of doubt, as I have obtained no experimental evidence with regard to them; probably most of them are pseudaposematic, but *Philagathes* may be a Müllerian mimic. Of the Hymenoptera the quick-flying *Notogonia* is the only scarce species with us; the other Aculeates all visit flowers more or less commonly. The Braconids are slow and very conspicuous fliers, being evidently protected by their very strong smell. The species of Hemiptera also occur commonly on low plants and bushes; the position of the Reduviids is not quite certain, as experimental proofs are lacking. The Asilid fly appears to be a very rare species and is doubtless a Batesian mimic.

## D. *Müllerian* (*Synaposematic*) *Groups in South African Coleoptera.* (G. A. K. M.)

### *a. Cantharid Group* (Represented on Plate XIX).

| | | |
|---|---|---|
| Coleoptera | *Cantharidæ* | Mylabris dicincta (fig. 1); M. tettensis (figs. 2–3); M. tricolor (fig. 4); M. oculata (figs. 5, 6, 13); M. holosericea (fig. 9); Actenodia chrysomelina (figs. 7, 8, 11); Decatoma lunata (figs. 10, 12). |
| | *Longicornia* | Cymatura bifasciata (fig. 14); Ceroplesis caffer (fig. 15); Anubis mellyi (fig. 16). |
| | *Phytophaga* | Clythra wahlbergi (fig. 20). |
| Hemiptera | *Lygæidæ* | Oncopeltus famelicus (fig. 17). |

The same species is sometimes repeated two or even three times in the Plate in order to show common variations in the pattern.

All the species of Cantharidæ in this group are abundant in Salisbury, some of them occurring in such numbers as to form a serious pest in the local flower-gardens. All those mentioned feed on flowers exclusively, except *M. holosericea* which seems to be more attached to grasses. In every case they emit a quantity of vesicating yellow juice from the antennæ and joints of the legs when handled, and also eject a liquid from their mouths; their flight is heavy and noisy, and they are most conspicuous insects in every way. *Ceroplesis caffer* is probably the commonest Longicorn in South Africa, attacking dead wood of almost any description, but particularly frequenting acacias. It has a slow conspicuous flight, and has been proved by experiment to possess distasteful qualities, though I have not noticed that it gives off any smell.

The Longicorn *Cymatura bifasciata* is specially attached to a species of *Lantana*, which grows to a fair-sized bush, and the insects occasionally may be found on it in some numbers. It is certainly a Müllerian mimic, as it has a strong smell, is very sluggish, and feigns death persistently when captured. It was refused with evident dislike by baboons. *Anubis mellyi* does not occur at Salisbury, but is fairly common at Umtali, further east, where it frequents the flowers of low plants. It is a brightly-coloured insect, and emits the strong characteristic smell of the diurnal Cerambycidæ.

### β. *Intermediate Group connecting the Cantharid and Coccinelloid Groups* (Represented on Plate XIX).

| | | |
|---|---|---|
| Coleoptera | *Cantharidæ* | Actenodia chrysomelina (figs. 7, 8, 11). |
| | *Phytophaga* | Melitonoma sp. nov. (fig. 18); M. truncatifrons (fig. 19); M. litigiosa (fig. 21); M. epistomalis (fig. 23); Antipus rufus (figs. 22, 25); Clythra lacordairei (fig. 24); Aulacophora festiva (fig. 26); Cryptocephalus 5-plagiatus (fig. 27); C. varioplagiatus (fig. 28); Syagrus marshalli (fig. 29). |

This group merges very gradually into the Mylabroid group on one hand, especially in those species where the rows of spots coalesce into transverse bands, and at the

other end of the series it converges to the Coccinelloid type, particularly in the *Cryptocephali*. The association is probably of a purely Müllerian character so far as the species mentioned are concerned. They all have very similar habits, occurring on low plants and flowers, and making no attempt at concealment. *A. festiva* is much more plentiful than the others, and is probably the dominant member of the group.

### γ. *Coccinelloid Group* (Represented on Plate XIX).

| | | |
|---|---|---|
| Coleoptera | *Coccinellidæ* | Epilachna dregei (figs. 40, 41); Chilomenes lunata (fig. 42). |
| Hemiptera | *Pentatomidæ* | Steganocerus multipunctatus (fig. 39). |

I have frequently found all these three species occurring together on the flowers of a *Lantana*, and as they are all common, conspicuous, and strong-smelling insects, the group is undoubtedly synaposematic.

### δ. *Group of small pale yellow and red Phytophaga with their Melyrid and Curculionid Mimics.* (E. B. P.)

With respect to a series of nine small brightly-coloured Coleoptera of about the same size (with the exception of *Urodactylus*, ♀ sp. ♀, which is conspicuously smaller than any of the others), Mr. Marshall wrote that he should be unwilling to hazard an opinion. It appears tolerably clear however that they form a beautiful Müllerian group, including perhaps a single Batesian mimic. All were captured at Salisbury, and, with the two exceptions noted below, in January 1899. The species are arranged below as they are on Plate XIX, where each is represented twice the natural size.

Phytophaga.

| | | |
|---|---|---|
| Platyxantha bicincta fig. 30. | Gynandrophthalma posticalis [or closely allied, M. Jacoby] (Feb. 1899) fig. 31. | Monolepta vincta [or closely allied, M. Jacoby] fig. 32. |
| Crioceris coronata, Baly (=balyi, Harold) fig. 33. | Paralepta ornata fig. 34. | Asbecesta ornata fig. 35. |

| Melyridæ. | | Curculionidæ. |
|---|---|---|
| Urodactylus, sp. ♂ fig. 36. | Urodactylus, sp. ♀ fig. 37. | Apoderus gentilis (Nov. 1898) fig. 38. |

The group consists of pale yellow insects with bright red anterior section, made up by thorax and head, of which the eyes only are black in some of the species, although in others black markings extend over a variable proportion of the cephalic surface. The elytra are crossed transversely by a black band at the base, and another at the junction of the third and posterior fourth of their length. In some species the anterior band, in others the posterior is reduced to two more or less widely-separated spots or patches. In the species of *Criocceris*, the anterior band is represented by four small black spots, two on each elytron. In the *Urodactyli*, the posterior band is represented by a semi-circular black mark with the concavity directed posteriorly on each elytron.

In spite of the variation in detail the species would produce the same effect at a little distance, and there can be no doubt about the interpretation of the whole as a synaposematic combination with the *Curculio* as a doubtful pseudaposematic member. Mr. Marshall states that there are many other species of about the same size which adopt the same warning pattern, including at least four additional species of *Melyridæ*.

Certain members of this group are very abundant and conspicuous in the spring months upon the Mosasa-tree (*Brachystegia* sp.).

E. *Comparison between certain Coleopterous Groups in Borneo and South Africa, with respect to Mimicry, Common Warning Colours, etc.* (G. A. K. M.)

[The following interesting comparison between the phenomena of mimicry and common warning colours in certain Coleopterous groups in Borneo and South Africa respectively, was made upon the receipt of a set of photographs of the material of Mr. Shelford's paper now being published by the Zoological Society.—E. B. P.]

*Salisbury, Jan.* 11, 1901.—I should be interested to know whether Shelford has proved the *Anthribidæ* to be

distasteful; from my knowledge of our fairly numerous South African species I should be much inclined to doubt it, as their colouring appears to be, without exception, protective, generally resembling bark or lichen; and although there are somewhat similarly-coloured Longicorns which frequent such surroundings, I should certainly class their colours as syncryptic. A somewhat similar criticism suggests itself with regard to the *Brenthidæ*, although I feel diffident in stating it, as the family is so very limited here. I know of only four species in Salisbury, all of which are sub-cortical and nocturnal in their habits, of comparatively rare occurrence, and of dull colouring. On the other hand, I have observed that the great majority of our smaller Lamiids adopt the forward position of the antennæ, which I have always regarded as procryptic, as there can be no doubt that it renders them much less conspicuous than if the antennæ were held out at an angle to the twig on which the insect sits. The procryptic nature of the position is well illustrated in the small and very elongate Longicorns *Hyllisia* and *Hippopsicon*, of which we have a few species, all of which frequent grass-stems in marshy places; they also have the elytra bifurcated, and this seems to be a common occurrence in all very elongate beetles. The Endomychid groups are very interesting. Unfortunately this family is extremely poorly represented here—only some three or four species, though the *Erotylidæ* are fairly numerous. In this latter the pattern with four yellow or reddish blotches on a black ground occurs also with us, and the insects are probably distasteful, judging by the extremely pungent smell emitted by the large *Eucaustes*. Curiously enough, just after getting your photographs I found under bark a large Endomychid (new to me) of this pattern, and with it occurred an admirable mimic, a Carabid *Thyreopterus flavosignatus* (Dej.). There is another Carabid *Arsinoë fraterna* (Pér.), also sub-cortical, which mimics it closely, but unfortunately I have no specimens now; I caught only two here six years ago.

F. *Note on Rhynchophora with Procryptic Colouring as Models for Mimicry.* (E. B. P.)

Dr. A. R. Wallace has always thought that the extreme hardness of the mimicked *Curculionidæ* and *Anthribidæ*

is the character which protects them ("Essays on Natural Selection," 1875, p. 94). In answer to a letter in which I drew his attention to Mr. Marshall's record of a large *Curculio* found in the crop of a guinea-fowl (see p. 350), he wrote, Feb. 5, 1901, "The large Malayan *Anthribidæ* are *intensely* hard. The guinea-fowl proves nothing, as these beetles are almost all *arboreal*, and their chief enemies are *smaller* birds. Their protective colours may save them from the *larger* insectivorous birds, their hardness from the smaller." The mimicry of Malayan *Curculionidæ*, *Anthribidæ*, and *Brenthidæ* by Longicorns cannot be doubted. The cases are too numerous and the details of the resemblance too precise to admit of any other explanation. In South Africa, on the other hand, Mr. Marshall shows that only the first group is mimicked, and of this he has sent me a very beautiful example. Experiments are greatly wanted, especially in Borneo, where all three groups abound. In addition to their hardness Mr. Shelford shows that the larger Bornean Curculios are defended by their great strength; they can even cause intense pain to man by clasping the fingers with their legs and digging the proboscis into the flesh. Such defences as hardness and strength depend for their success on the size of enemies; for even hardness could not avail against an enemy large enough to swallow the beetle whole, so that it could be ground down in the gizzard, or the interior slowly extracted by digestive fluids gaining access by the joints and other apertures. Defence by a sting, a nauseous taste or smell, or unwholesome qualities, is effective against enemies of all sizes and all degrees of strength, although failing against occasional specially-adapted foes. It is possible that these considerations may enable us to understand why it is that certain *Rhynchophora* are remarkable among Coleoptera for combining a cryptic colouring with sufficient immunity to render them feasible models for mimicry. The ordinary methods of active defence among vertebrates—the power of biting or pecking, of kicking or tearing with hoofs or claws—together with the passive resistance of a spiny or hard external covering, are almost invariably associated with cryptic colouring and modes of life favouring concealment. The probable explanation is that all such methods of defence must fail before large and important classes of still stronger enemies or foes with cunning sufficient to circumvent the passive

defence. Such enemies are numerous enough and deadly enough to make the increased danger of a conspicuous appearance far greater than any advantage gained by the warning off of smaller and weaker animals. Such a defence as that of the skunk, on the other hand, appeals to enemies of many classes, and is quite independent of strength or size. Here and there special animals, probably powerful birds with deficient sense of smell, can endure the defensive odour, and to these the skunk would be an easy prey; but on the whole the increased danger of a conspicuous appearance and slow movements is far more than compensated by the warning off of an immense number of would-be enemies. Cases like that of the skunk are very common among insects, while those of active defence are very rare. Even the passive defence of a spiny or hairy covering is very different from that ordinarily adopted among vertebrates, because in the insect the hairs and spines are themselves a cause of unpalatability, and often of intense irritation, so that they tend to be associated with an aposematic appearance. It is, however, probable that the intensely hard Rhynchophora with a cryptic appearance, and especially the largest and most powerful *Curculionidæ*, are strictly comparable with the large number of vertebrates which also unite the methods of concealment with very efficient modes of active or passive resistance. Certain of the largest *Curculionidæ* possessing red marks on a black ground appear to possess an aposematic appearance, and these may be distasteful, although the conspicuous appearance may only indicate an excessive hardness and thickness of chitin which, coupled with the great size, may be a most efficient defence against a majority of enemies. Mr. Marshall tells me that the largest South African Curculios of the genus *Brachycerus*, such as *B. apterus*, are purely terrestrial, move slowly, and freely expose themselves, like our European distasteful species of Phytophagous *Timarcha*. Under these circumstances the intense black ground-colour and red spots of *B. apterus* must render it remarkably conspicuous, and it would be of great interest to ascertain, by a number of experiments on many insect-eaters, whether so pronounced an aposeme may indicate hardness alone or hardness combined with some other special protection.

The small size of the *Brenthidæ* renders it improbable

that hardness alone can be sufficient protection to the mimicked species, such as the Bornean *Diurus furcillatus*, and we are led to suspect the existence of unpalatability. In the cabinet the specimens seem to be markedly cryptic, but Mr. Shelford assures me that they are very commonly found on flowers, where their dull dark colours would be most conspicuous. Above all things experiments with insect-eating animals are greatly needed to throw light on this most puzzling and exceptional occurrence, viz. the existence of large numbers of models for mimicry among Rhynchophora with an apparent, and certainly in many cases an actual cryptic appearance.

## 32. Common Warning Colours in South African Hymenoptera and the Mimicry of them by Insects of other Orders. (G. A. K. M.)

A. *Group with Black Bodies and Dark Blue Wings, chiefly Fossores.*

Hymenoptera

| | |
|---|---|
| *Apidæ* (Pl. XXI) | Xylocopa hottentota (fig. 18); X. carinata (fig. 19). |
| *Eumenidæ* (Pl. XXI) | Eumenes tinctor (figs. 14, 15); E. dyschera (figs. 16, 17). |
| *Sphegidæ* (Pl. XXI) | Sphex bohemani (figs. 1, 2); S. cyaniventris (fig. 3).<br>S. pelopeiformis (figs. 4, 5); S. xanthocerus (fig. 6).<br>S. umbrosus (fig. 7); Sceliphron chalybæum (fig. 8).<br>Tachytes natalensis (figs. 9, 10); Ammophila ludovicus (figs. 11, 12).<br>A. beniniensis (fig. 13). |
| *Pompilidæ* (Pl. XX) | Salius atropos (fig. 14); S. vindex (fig. 15).<br>S. dedjax (fig. 16); S. regina (fig. 17); S. obscurus (fig. 18).<br>Pompilus sepulchralis (fig. 19); P. frustratus (fig. 20). |
| *Scoliadæ* (Pl. XX) | Elis lachesis (fig. 3); E. fasciatipennis (figs. 4, 5).<br>Scolia alaris (figs. 6, 7, 8); S. fraterna (figs. 9, 10).<br>S. cyanea (figs. 11, 12); S. affinis (fig. 13). |
| *Tiphiidæ* | Tiphia rugosa (Pl. XX, fig. 2). |
| *Mutillidæ* | Mutilla atropos (Pl. XX, fig. 1). |

| | | |
|---|---|---|
| Coleoptera (Pl. XXI) | *Cetoniidæ* | Trymodera aterrima (fig. 22). |
| | *Cantharidæ* | Epicauta pectoralis (fig. 23); E. subcoriacea (fig. 24). |
| | | E. cœlestina (fig. 25); Lytta mœsta (fig. 27). |
| Diptera | *Asilidæ* (Pl. XXI) | Laparus sp. (fig. 20); L. ? tabidus (fig. 21). |
| | *Bombyliidæ* | Exoprosopa umbrosa (Pl. XX, fig. 22). |
| | *Tabanidæ* | Tabanus ? biguttatus (Pl. XX, fig. 24). |
| | *Tachinidæ* | Orectocera (Paraphania) diabolus (Pl. XX, figs. 21, 23). |
| Hemiptera (Pl. XX) | *Reduviidæ* | Reduvius sp. (fig. 26); Harpactor tristis (fig. 27). |
| Lepidoptera | *Zygænidæ* | Tascia homochroa (Pl. XX, fig. 25). |

Among the Mashonaland Hymenoptera the most dominant and conspicuous group is certainly that which comprises the species having a generally black coloration with more or less metallic purple wings; for not only is the number of component species a large one, but the individuals are likewise very numerous, since the group contains many of our commonest large Aculeates, such as *Eumenes tinctor*, *Salius vindex*, *Scolia cyanea*, etc. All of the species of this large group, which are figured in Plates XX and XXI, commonly visit flowers, and owing to the numbers in which they often occur, and their close interresemblance, it is very difficult for one who is not an expert to distinguish the species without examining them in the net. The Scolias are the heaviest and slowest flying species of the group, though the largest Pompilids run them close in this respect, being very conspicuous both on the wing and when settled, and it seems probable that these two types constitute the nucleus of the mimetic group towards which the other genera have converged. Moreover, several of the large species of *Salius* (*Myginnia*) advertise their offensive qualities by their loud, rattling flight, which can be heard at a considerable distance. This is specially noticeable in *S. vindex*, which sounds as though it were going by clockwork, the noise often attracting one's attention when the insect is flying high above the trees. Among the other species the *Eumenes* also fly somewhat leisurely, and are not readily disturbed when feeding. But the species of *Sphex* and *Tachytes* are very active, restless insects with a swift, dodging flight. Of the Coleoptera coming into this group, *Trymodera aterrima* is the only flower-feeding species, occurring chiefly on *Protea*, the flowers of which are much frequented by Hymenoptera.

*Lytta mœsta* and all the species of *Epicauta* are purely terrestrial in their habits, all being very common insects and evidently protected by their vesicating properties. The blue-winged Pompilids when running on the ground bear a distinct general resemblance to these insects. Of the five species of dark-winged flies, *Exoprosopa umbrosa* is the only one which visits flowers, and this has a rapid flight. The two *Lapari* and *Orectocera* (*Paraphania*) *diabolus* are to be found settling conspicuously on low plants, and have a comparatively slow flight. *Tabanus biguttatus* is a rapid flier, with the usual habits of the genus. The Zygænid moth, *Tascia homochroa*, is a very common species; it is occasionally seen on flowers, but is more frequently observed settling in a conspicuous manner on shrubs and plants. It is very sluggish in habits and emits a strong-smelling liquid when crushed.

B. *Mimicry of Diploptera by Fossores and Insects of other Orders.* (E. B. P.)

The dominant members of the group described above are evidently the Fossores, the Diploptera and Anthophila being represented by only two species each.

It is therefore somewhat surprising to note that in one of the Scolias (Figs. 6, 7, 8, Plate XX), evident mimicry of Diploptera has been brought about in a very interesting way. The outer parts of both wings, except the costal area of the fore-wing, have become extremely transparent and invisible, possessing a peculiarly illusive quality probably due to approximation of the refractive index to that of air. The effect is that both in flight (Figs. 6, 8) and at rest (Fig. 7) the resemblance to the much narrower wings of Diploptera is most striking. The resting resemblance is peculiarly interesting, for the dark areas of the wings exactly resemble the narrow longitudinally-folded organs of the Diploptera, as may be seen by comparing Fig. 7 on Plate XX with 17 on Plate XXI, or 11 and 13 on Plate XXII, while the transparent portions of the Scolia, although in two layers (compare Figs. 1, 4, 10, etc., on Plate XX), are not seen. The transparency is well shown in Fig. 8, Plate XX, where the dark apex of the wing of *Scolia fraterna* was made to underlie the transparent part of that of *Scolia alaris*, when the photograph was taken for the preparation of the plate. The underlying wing loses

neither its sharpness of outline nor, in a print prepared from the negative, any of the detail of the surface. A tendency in the same direction is manifest in *Elis fasciatipennis* (Fig. 5), but it is hardly noticeable in the representation of the resting position in Fig. 4. Mr. Marshall informs me that the Diplopterous appearance of *Scolia alaris* is very marked during life, both at rest and in flight.

It is interesting to inquire for the possible reason of this mimicry. Fabre ("Insect Life," translation, London, 1901, pp. 99, 100) states that the Fossores, using their sting for hunting and providing food for the larvæ, are much less prone to employ it in defence than the Diploptera, in which it has this latter meaning alone, and not only so, but when used it is far less painful in the former than the latter. The *Pompilidæ*, he considers, produce the most painful effect, but far less than those which follow from the sting of a bee. On the other hand, my assistant, Mr. A. H. Hamm, who has had great experience of our British Aculeates, and always takes them out of the net with his fingers, thus gaining very exceptional knowledge of their relative powers in this respect, does not altogether share Fabre's opinion. He states that while the common wasp, and of course the hornet, for his experience includes even this insect, produce more pain than any other British Aculeate (I leave the hive-bee out of account), many of the Fossores produce more pain and use their sting more readily than other Aculeates. At the same time Mr. Hamm's treatment is one that the mildest Aculeate may be expected to resent if its sting can pierce the skin of the fingers, and the question is rather whether the Diploptera are not recognized as more formidable than the Fossores by the natural enemies of insects. It is very probable that this is the case, the combined attack made upon enemies incautiously disturbing a society being one element in producing an increased respect for single individuals of the same kind or with the same general appearance.

When an illustration of *Scolia alaris* was shown to the Entomological Society on March 5, 1902, and this interpretation suggested, Colonel Yerbury and Mr. Verrall pointed out, at the close of the meeting, that similar opacity of the costal area of the wing and transparency in other parts was characteristic of many Diptera mimetic of Hymenoptera.

and might have a similar meaning. Mr. A. J. Chitty also suggested that the same interpretation applies to the Sesiid moth shown on Plate XXII, figs. 15, 16. In this latter case the shape of the opaque area would present during flight a very close approximation to the outline of the narrow fore-wing and small hind-wing of the Diploptera, many of which are figured on the same plate as the Sesiid (compare Figs. 7, 8, 10, 12, etc., with Fig. 16).

It seems probable that the case of *Scolia alaris* will throw much light on the manner in which the mimicry of Aculeates is brought about in insects of many orders.

C. *Group with Black Bodies and Yellow Tails, chiefly Diploptera* (Represented on Plate XXII).

HYMENOPTERA.

*Scoliadæ.*
Scolia erythropyga (figs. 1, 2).

*Pompilidæ.*
Salius tamisieri (figs. 3, 4).
,, spectrum (fig. 5).

*Eumenidæ.*
Rhynchium synagroides (fig. 6).
Synagris abyssinica (fig. 7).
Synagris mirabilis (fig. 8).
Synagris emarginata (figs. 9, 13).
Synagris analis (figs. 10, 11).
Synagris xanthura (fig. 12).
Eumenes dyschera (fig. 14).

LEPIDOPTERA.

*Sesiadæ.*
Trochilium sp. (figs. 15, 16).

DIPTERA.
Bombylius sp. nov. (fig. 17).
Silvius pertusus (fig. 18).

All the Hymenoptera in this group are common insects occurring in some numbers on suitable flowers. Their metallic blue wings and yellow tails make them very noticeable objects, and their flight is leisurely. Of the *Trochilium* only two specimens were taken—both of them on the wing, when the resemblance to a large *Synagris* was most remarkable, being much heightened by the transparent edging of the hind-wing, which is thus made to appear of about the same size and shape as that of the wasp. Of the two Diptera, one, the *Bombylius*, is very common, especially about flowers; the other, *Silvius pertusus*, is apparently scarce. There is not sufficient evidence to judge on their true relation to the group.

[The conspicuous yellow apex of the abdomen probably acts as an easily seen directive mark indicating the sting. Compare pages 510 to 512.—E. B. P.]

D. *Group with Dark Bodies, Central White Patch and Red-Brown Tails: Megachile the Models* (Represented on Plate XXI).

| Hymenoptera. | Diptera. |
|---|---|
| Megachile chrysorrhœa (fig. 29). | Laphria nr. flavipes (fig. 31). |
| ,, nasalis (fig. 28). | |
| Cœlioxys pusilla (fig. 30). | |

The *Megachile* bees mentioned above are both common, not only visiting flowers, but also, during the drier months, occurring in some numbers on damp sand or mud near water. The parasitic *Cœlioxys* may be seen with them in both stations, but is a much scarcer insect. The Asilid is also an uncommon species, having the usual habits of its congeners and settling about on low plants.

E. *Group with Black Thorax and Yellow Abdomen: all Hymenoptera* (Represented on Plate XXIII).

| | |
|---|---|
| *Tenthredinidæ* | Athalia bicolor (fig. 11). |
| *Chalcididæ* | Chalcis bicolor (fig. 10). |
| *Scoliadæ* | Elis aureola (fig. 1). |
| *Crabronidæ* | Philanthus fuscipennis (fig. 2); P. diadema (figs. 3, 4); P. bucephalus (fig. 5). |
| *Eumenidæ* | Rhynchium radiale (fig. 6); R. rubens (figs. 7, 8). |
| *Andrenidæ* | Sphecodes rufiventris (fig. 9). |

This is a beautifully compact and uniform little group, and is specially interesting owing to its comprising species of no less than six families of Hymenoptera, which exhibit great differences in their food and general habits—especially in their earlier stages. Yet the imagines may be frequently observed all flying together about the same patch of flowers, and the uniformity of their coloration is then very striking. All the species are common and efficiently protected, so that the association is probably Müllerian.

F. *Group with Black Bodies, Blue Wings, and Yellow or Red Thorax* (Represented on Plate XXIII).

| | | |
|---|---|---|
| Hymenoptera | *Apidæ* | Xylocopa lateritia (fig. 12); X. flavorufa (fig. 13). |
| | | Xylocopa olivacea (fig. 16); X. modesta (fig. 17). |
| | | Podalirius acraënsis (fig. 14); Anthophora ? basalis (fig. 15). |
| | *Scoliadæ* | Elis cælebs (fig. 18). |
| Lepidoptera | *Sesiadæ* | Melittia sp. (fig. 19). |

This group forms another interesting illustration of the way in which the larger mimetic groups tend to merge one into the other. Such species as the *Podalirius* and *X. olivacea* in which the anterior yellow is largely developed clearly belong to the outlying portions of the Lycoid group (Plate XVIII), whereas *Elis cælebs* has more affinity with the succeeding group; and this latter again merges away into the great black group with blue wings (Plates XX and XXI). The two largest Xylocopas (*X. lateritia* and *X. flavorufa*) only belong to the outskirts of the association, as the red of the thorax is in them of a much darker tint and does not show up well in the Plate. All the Hymenoptera of the group are found plentifully on flowers; but as regards the *Melittia*, the specimen figured is, I believe, the only one known.

G. *Group with Black Bodies, Blue Wings, and Red or Yellow Heads* (Represented on Plate XXIII).

| | | | |
|---|---|---|---|
| Hymenoptera | *Pompilidæ* | Pompilus marshalli (fig. 20); P. dichrous (figs. 21, 22); P. anticus (fig. 24). | |
| | | Pompilus lascivus (fig. 23); Salius tamisieri (fig. 25). | |
| | *Sphegidæ* | Tachysphex fluctuatus (fig. 26). | |
| Coleoptera | *Longicornia* | Jonthodes sculptilis (fig. 28). | |
| Diptera | | Bromophila caffra (fig. 27). | |

Converging towards these but with black wings instead of blue are the Braconid *Iphiaulax ruber* (Fig. 31) and the Cantharid *Eletica rufa*, var. (Fig. 29).

This is only a subdivision of the group of black-bodied and blue-winged insects. The Hymenoptera have all much the same habits as the species contained in that group, though they are mostly of much smaller size. The Longicorn *Jonthodes* bears a very good general resemblance to the blue-winged, yellow-legged *Salius dedjax*, owing to its blue elytra and yellow legs; it is not a particularly common species, being diurnal and arboreal in its habits. It possesses a strong scent-like smell, and the mimicry is probably Müllerian. The *Bromophila* fly is very plentiful; it is the most sluggish fly known to me, and settles about on trees and bushes in a very conspicuous manner. It ejects a yellow liquid from the mouth when handled, and was refused when offered to my baboons and *Cercopithecus* monkey.

H. *Group with Black and Yellow-Banded Bodies: all Hymenoptera* (Represented on Plate XXIII).

| *Scoliadæ.* | *Pompilidæ.* | *Ichneumonidæ.* |
|---|---|---|
| Myzine capitata (fig. 35). | Pompilus festivus (fig. 34). | Metopius discolor (fig. 36). |

In Europe, owing to the predominance of the genus *Vespa*, black and yellow bands constitute a very dominant type of coloration among the Hymenoptera; but in Mashonaland (where *Vespa* is entirely absent) this pattern is of comparatively rare occurrence, and, except in the case of one large *Scolia* and some *Bembex*, is confined to small insects. The two Aculeates in the above group are common frequenters of flowers, and to them might have been added several small species of *Elis*, etc.; the Ichneumon is common in woods.

I. *Group with Dark Wings and Black-and-Yellow Legs: Ichneumonid Models* (Represented on Plate XXIII).

| Hymenoptera. | Coleoptera. | Hemiptera. |
|---|---|---|
| *Ichneumonidæ.* | *Longicornia.* | *Reduviidæ.* |
| Ospryncholus flavipes (fig. 32). | Litopus dispar (fig. 30). | Pirates æneicollis (fig. 33). |

The *Litopus* is evidently one of the protected Cerambycids, as shown by its diurnal habits, blue elytra, brightly-banded legs, and strong smell. The *Pirates*, with its dark wings and black-and-yellow legs, shows a distinct approximation to the former insect, which is probably of a Müllerian nature, as it is capable of emitting a strong and unpleasant smell, can pierce very effectively with its strong rostrum, and has the power of stridulation. *Ospryncholus* is also a conspicuous and very common insect. In South Africa it seems to be principally parasitic upon *Pelopœus spirifex*, and it is a curious thing that although these two insects are so very different in coloration (except the hind-legs), yet there is an undoubted similarity between them when seen together on the wing.

J. *Black and Yellow-Barred Braconid Group and Mimics* (Represented on Plate XVIII).

| | | |
|---|---|---|
| Hymenoptera | *Braconidæ* | Phanomeris dubius (fig. 59). |
| | *Ichneumonidæ* | Pimpla tuberata (figs. 60, 61). |
| Hemiptera | *Reduviidæ* | Callilestes stigmatellus (fig. 62). |

This is a beautiful little group, presenting very striking resemblances. The *Phanomeris* is doubtless the chief model, being a common species with a strong smell and a slow, conspicuous flight. The colouring of the *Pimpla* is probably Müllerian, while that of the Reduviid is certainly Batesian. The latter is evidently a very scarce insect, the only example which I have met with having been captured accidentally in mistake for the Braconid, to which it bears a wonderful resemblance on the wing.

K. *Black and Red Braconid Group and Mimics* (Represented on Plate XVIII).

| | | |
|---|---|---|
| Hymenoptera | *Braconidæ* | Bracon coccineum (figs. 53, 54); Iphiaulax pictus (fig. 55); I. flagrator (fig. 56). |
| Coleoptera | *Longicornia* | Oberea scutellaris (fig. 57). |
| Hemiptera | *Reduviidæ* | Callilestes bicolor (fig. 58). |

In this group the pattern is certainly set by the *Braconidæ*, which are common, conspicuous, slow-flying insects, protected by their strong smell. The Reduviid is an admirable mimic of them (Batesian, as I believe) both at rest and on the wing; it is a scarce species, and frequents the same stations as the Braconids. The Longicorn agrees also in the latter respect, but its exact relationship to the group is doubtful; normally it is not a very common species in Salisbury, but in one or two seasons it has appeared quite plentifully, settling on low plants on wooded kopjes.

L. *Diptera Mimicking Single Species of Hymenoptera rather than the General Type of a Group.*

*a. Asilid Fly Mimicking Xylocopid Bee* (Represented on Plate XXII).

| Hymenoptera. | Diptera. |
|---|---|
| Xylocopa flavorufa (fig. 19). | Hyperechia marshalli (fig. 20). |

[With reference to these insects Mr. Marshall wrote:]

*Salisbury, Feb.* 12, 1899.—I was immensely delighted on catching the large Asilid fly, and I have been delaying the

box on purpose to include the large *Xylocopa* bee which it mimics so admirably; but though usually they are common enough I have not seen a single example for the last three weeks. The fly completely deceived me when on the wing, but I happened to notice it settle on the trunk of a tree, and it struck me there was something curious about the way it alighted for a *Xylocopa*. It is the only example I have seen.

*Salisbury, April*, 25, 1899.—I have already got a couple of the *Xylocopas* for you, and I have seen another specimen of the *Laphria* that mimics them, but unfortunately failed to catch it.

### β. *Syrphid Fly Mimicking a Wasp* (Represented on Plate XXIII).

| Hymenoptera. | Diptera. |
|---|---|
| Polistes marginalis (fig. 40). | Ceria gambiana (fig. 41). |

This is an excellent and typical case of Batesian mimicry. The wasp is a very common species, building a small hanging nest on bushes or grass-stems. Like most of its congeners it is a somewhat sluggish insect, and instead of flying away when approached, adopts a bold and defiant attitude, stinging sharply when disturbed. It visits flowers freely, and may there be seen in company with the *Ceria*, which resembles it so closely (especially on the wing) that I have been deceived by it over and over again.

### γ. *Bee-like Group* (Represented on Plate XXIII).

| Hymenoptera. | Diptera. | |
|---|---|---|
| *Apidæ.* | *Syrphidæ.* | *Asilidæ.* |
| Megachile apiformis (fig. 37). | Eumerus, sp. nov.? (fig. 38). | Laxenecera mollis (fig. 39). |

The resemblance of the two flies to the *Megachile* is very marked in the field, especially in the case of the *Laxenecera*; although the plate does not do justice to the *Eumerus*. I have on several occasions seen all three species flying together in the vicinity of flowers.

M. *Group of Ant-like Insects captured together* (Represented $1\frac{1}{2}$ times the natural size on Plate XIX).

| | | |
|---|---|---|
| Hymenoptera | *Formicidæ* | Camponotus sericeus (fig. 54); C. cosmicus (figs. 55, 56); C. sp. (fig. 53). |
| Hemiptera | *Pyrrhocoridæ* | Megapetus atratus (figs. 57, 58). |
| Orthoptera | *Locustidæ* | Myrmecophana ? fallax (fig. 59). |

The above insects were all caught on the same day (Feb. 17, 1901) on a single plant—a small bushy vetch. The Pyrrhocorid habitually frequents this plant, being fond of sucking the young pods; the ants are more or less ubiquitous, but are principally attracted to this vetch by the juice which exudes from the injuries made by the bug; the *Myrmecophana*, which is apparently a very rare insect, was probably only a chance visitor. The latter, in spite of its long antennæ, bears a very strong resemblance to an ant, and might very readily be passed over for one of these insects; it is probably a Batesian mimic. The bug is not nearly so ant-like in its mature form (which is shown in Plate XIX) as in its earlier stages, at which period the similarity is most striking both in shape and movements. The insect is a comparatively common one, and the mimicry has probably a Müllerian character.

[The following extracts from letters refer to this interesting group. Mr. Malcolm Burr, to whom I have shown the Locustid, thinks that it may be the same species as *M. fallax*, inasmuch as the habits of the latter are not certainly known, and the green marking which obliterates the unant-like parts of the body-form had faded to a pale yellowish tint much like that of the corresponding parts of the specimen described by Brunner von Wattenwyl (verhandl. d. K. K. Zool.-botan. Ges. in Wien, Bd. xxxiii, 1883, Pl. XV, figs. 1*a* and 1*b*).—E. B. P.]

*Salisbury, April* 25, 1899.—The Locustid ant-mimicker *Myrmecophana* occurs both here (Mashonaland) and in Natal, though very rarely, but it is perhaps a different species from *M. fallax*. It does not live on the ground but on low plants, which are also frequented by the ant it mimics, and the light parts are pale green; we have also a bug which mimics the same ant.

*Salisbury, April* 19, 1901.—I expect you will be glad to have an example of *Myrmecophana*, it makes a grand series with the ants and bugs; the two latter can often be

found together on a certain vetch, but it was a bit of luck getting the Locustid there too.

### 33. Mimetic Resemblance of Mantispidæ to Hymenoptera. (E. B. P.)

Prof. W. M. Wheeler, of the University of Texas, was, so far as I am aware, the first to observe the mimicry of Hymenoptera by *Mantispidæ*. "While studying the prairie insect fauna of south-eastern Nebraska early in the summer of 1888," he observed that *Mantispa brunnea* (Say.) closely resembled *Polistes variatus* (Cress), resting half-concealed like the wasp "on the petioles in the terminal leaf-clusters of the golden rods." He was at first quite deceived, and took care to avoid being stung. "The colouring of the *Polistes* is carefully copied; the body is banded with yellow, brown, and black, the wings are smoky brown, and the legs yellow. While lying in wait the *Mantispæ* closely appose their large raptorial fore-legs to the lateral faces of the prothorax, which, when these appendages are extended, is so narrow as to resemble but slightly the wasp's thorax. The wings are carried in the same manner by both insects. Several times during the course of a week I found these two insects . . . resting in the same position, both intent upon the slaughter of the many insects . . . which swarmed about the rank vegetation" (Proc. Nat. Hist. Soc. Wisconsin, U.S.A., April 1889, p. 217). Professor Wheeler considers it to be an example of protective mimicry.

Mr. R. Shelford has recently observed that at least four species of *Mantispa* from Borneo and Singapore are beautifully mimetic of Ichneumons, Bracons, or Aculeates. His observations are now being published by the Zoological Society. I sent a photograph of some of his examples to Mr. Marshall, who replied with the observation printed below. These interesting records constitute, so far as I am aware, a distinct addition to the list of insect mimics of the Hymenoptera. Mr. McLachlan, whom I have consulted, writes that he cannot find anything further recorded about such resemblance on the part of *Mantispidæ*. There can be little doubt, after these observations from three such widely-different regions, that mimicry of the Hymenoptera will prove to be prevalent in the group. Mr. Shelford and

Mr. Marshall both call attention to the cause which has doubtless prevented the fact from being generally recognized at an earlier date, viz. the changes which take place in dried specimens of *Mantispa*. On this account, and because of the important part played by movement, the appreciation of the mimetic resemblance required the study of the living insect.

"*Salisbury, Sept.* 21, 1900.—The large South African *Mantispa grandis* is an excellent mimic, on the wing, of the *Belenogaster* wasps. I caught one at Malvern, on my way home in 1896, which I gave to McLachlan. This insect completely took me in; it flew out of a loquat-tree which I was beating, and I at once took to my heels thinking I had struck a nest of these vicious wasps. Fortunately I kept an eye on the insect, and, as it seemed to be a species of *Belenogaster* new to me, I followed it up and caught it, when to my surprise and delight it proved to be only a *Mantispa*. Unfortunately in a dried specimen the resemblance is much spoilt by the shrivelling and discoloration of the abdomen."

## 34. Convergent Groups of South African Hemiptera (G. A. K. M.)

### A. *Black and Red Lygæoid Group* (Represented on Plate XIX).

*Lygæidæ* { Lygæus rivularis (fig. 44); L. elegans (fig. 46); L. crudelis (fig. 47); Graphostethus servus (fig. 45).
*Reduviidæ* Reduvius sp. (fig. 43).

In this group I consider that the Lygæids form a Müllerian association, of which the *Reduvius* is probably a Batesian mimic. The former insects are very abundant, occurring on many different plants, but the *Lygæi* are especially fond of the balloon-like seed-vessels of *Gomphocarpus*. The *Reduvius* inhabits much the same stations, though I have never seen it (to my remembrance) actually in company with the Lygæids, and it is a decidedly rarer insect.

B. *Group of Yellow Hemiptera with Black Apex and one or two Black Bars* (Represented on Plate XIX).

At Malvern, Natal.

| *Pyrrhocoridæ.* | *Reduviidæ.* |
|---|---|
| Dysdercus nigrofasciatus (fig. 49). | Phonoctonus nigrofasciatus (fig. 48). |

At Salisbury, Mashonaland.

| *Pyrrhocoridæ.* | *Reduviidæ.* |
|---|---|
| Dysdercus superstitiosus (fig. 50). | Phonoctonus formosus (fig. 52). |
| ,, intermedius (fig. 51). | |

The significance of the mimicry in this group has not yet been tested by experiment, and the exact relationship of the Reduviids to the common and undoubtedly distasteful *Dysdercí* is not quite clear. Dr. Dimock Brown, who observed *Phonoctonus* in company with myself at Malvern, suggested that its colouring may be pseudepisematic, and that it may feed upon the *Dysdercus* which it mimics so marvellously well. Personally I incline rather to the belief that both this species and the northern *P. formosus* are Batesian mimics. Both species occur but rarely (indeed, of the latter, I know only two specimens), they do not possess the strong smell which characterizes some of the Reduviids, and their jointed rostrum is a very inefficient weapon for protective purposes. I am not aware that they have been observed feeding on *Dysdercí* or even in company with them (cf. G. Breddin, Zeitsch. f. Naturw. 1896, pp. 36–38).

[Breddin considers the resemblance of the Reduviid to be a case of aggressive (pseudepisematic) mimicry, as he thinks with Dr. Dimock Brown it would prey on the *Dysdercus*. I believe that all such groups in the Hemiptera are synaposematic.—E. B. P.]

## 35. Miscellaneous Observations on South African Insects. (G. A. K. M.)

### A. *Note on the Courtship of Limnas chrysippus.*

*Salisbury, June* 26, 1900.—In some old notes I find the following observation on the courtship of *chrysippus*. When first observed the female was settled on the

ground and was sharply fluttering her wings to keep off the male which was hovering above her. Whenever she rested for a moment with open wings the male would drop down on her, trying to settle on the costa of her fore-wing in such a position that the badge on his hind-wing came directly down on her head; and while hovering over her, his position was usually at right angles to hers, which renders it probable that the badge is some sort of scent-gland used for attractive purposes. The female however kept on fluttering pretty incessantly, and the male kept bumping down on her. Then another male came round and the first one went off and had a skirmish with him and drove him away. The female then took flight, the male usually keeping above her and trying to beat her down to the ground again. The female, on settling, renewed her defensive fluttering, and the male, apparently getting tired, flew off. The whole observation occupied five minutes. I never saw any use made by the male of his curious terminal tufts.

### B. *The possible meaning of the Sac of Female Acræinæ.*

*Malvern, May* 14, 1897.—The species in which the sac is best developed are *Acræa neobule* and *A. horta*. With regard to the use of the organ, I remember making some observations at Salisbury in 1894 on *A. caldarena* and *A. nohara-halali* while ovipositing, and I then came to the conclusion that the sac was of no use during laying, being apparently rather an obstruction than otherwise. I therefore rather incline to your second suggestion, that it is probably to prevent copulation a second time. This view moreover seems to be borne out by what I have noticed in the courtship of the insects. So far as I have at present observed, Acræas appear to be the only butterflies which indulge in the system of "marriage by capture." In such of the *Nymphalinæ* as I have watched, the males have in no case attempted to seize the females, which, when anxious to escape their addresses, did so either by dodging among the vegetation or soaring. The females of some *Pierinæ* (notably *Belenois, Pinacopteryx*) have a very noticeable method of refusing the males; they settle with wings outspread but with fore-wings directed backwards so as almost to cover the hind-wings, and the abdomen is

raised in the air. This position is probably to prevent the male running along the side, for copulation is effected from the side. It might however be done in order to allow the male to see by her abdomen that she was gravid, for I have a case in my note-book (*P. pigea*) in which the male ran up and felt the abdomen with his palpi and then flew off. In the Acræas however I have observed several cases of copulation taking place in *A. petræa* and *A. horta*, and in all of them the male seized the female on the wing, grasping her with his intermediate legs about the thorax or base of the fore-wings, and they would fall struggling to the ground, where coition would take place. If this is the normal method of copulation, and unfortunately my observations have been too few to enable me to feel sure of it, then any organ which would protect the female from the attentions of an unlimited number of males would not only be useful but absolutely necessary.

*Malvern, July* 15, 1897.—The other day I saw a pair of *Acræa encedon* struggling together on the ground, the male clasping the female round the thorax from below. Unluckily a second or two after I noticed them they separated, so that I had not time to see whether it was really the sac which prevented coition. However I caught the female and found she had the sac fully developed and hard.

### C. *A Rhodesian Muscid Fly Parasitic on Man.*

[Mr. E. E. Austen informs me that the fly sent by Mr. Marshall belongs to the *Muscidæ*, and is certainly a near ally of the genus *Bengalia*. A closely similar or possibly identical species with precisely similar habits occurs on the West Coast of Africa. Mr. Austen's observations upon this latter entirely confirm Mr. Marshall's conclusions as to the method by which the larva enters the skin. Mr. Austen proposes to publish a full description of the species—E. B. P.]

*Salisbury, April* 19, 1901.—I should be glad to know the name of the parasitic fly I send. It has been a great scourge this year in Salisbury, especially among young babies, the maggots forming a painful boil-like swelling under the skin. One baby had no less than sixty maggots extracted from it, and there have been several cases in which they have had a dozen or more.

*Salisbury, Sept.* 27, 1901.—The fly which lays eggs in man is very common here, but I have no specimens by me; I will catch you a series as soon as they appear again. The one I sent you was a male, the female is very much larger. I am much puzzled to understand how the larva obtains an entrance into the skin. It certainly cannot be through the stomach as in the case of some other bots. I fancy the egg or living larva must be laid on the clothing, and the latter being very minute might wander about and eventually enter the skin through a pore without being felt. The position of the bots in many cases renders it impossible for the egg to have been placed under the skin by the mother.

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# APPENDIX.

*Description of a new species of* Hyperechia, Schin. (Family Asilidæ), *from Mashonaland.* By Ernest E. Austen.

Hyperechia, Schiner:

Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien, xvi. Band, p. 673 (1866).

*Hyperechia marshalli*, sp. nov. (Pl. XXII, f. 20.)

♂. Length 28 millim.

*Black, abdomen steely; cheeks, posterior margin of thorax in front of scutellum, outer side of front tibiæ, under side of thorax between bases of legs and in front of front coxæ, and outer side of middle femora, except apical fourth, clothed with orange-rufous* hair: fringe on posterior margin of thorax very conspicuous, and more ferruginous† than orange-rufous.*

*Front* and *face* clothed with ochraceous hair; *mystax* ochraceous above and black below, with two or three black hairs in the middle

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* Ridgway, "A Nomenclature of Colors" (Boston: Little, Brown and Coy., 1886), Pl. IV, 13.

† Ridgway, *op. cit.*, Pl. IV, 10.

line above. Tips of *front femora* on outside clothed with orange-rufous hair; a large tuft of similar hair on the pleuræ below the humeral angles. *Thorax* duller than abdomen, and, except on posterior margin and also in front, where there is some ochraceous pile, clothed with very short black hair. *Legs* thickly fringed with black hair, except where otherwise stated. *Wings* of the usual blackish-brown tint, with a slightly purplish sheen, which, however, is not so conspicuous as in the case of *H. xylocopiformis*, Walker.

Salisbury, Mashonaland; Feb. 1899 (G. A. K. Marshall): one specimen. Type in the Hope Museum, Oxford.

I have much pleasure in associating this fine new species with the name of its discoverer.

It may be of interest to note that the genus *Hyperechia* occurs in the Oriental as well as in the Ethiopian Region: *Hyperechia* (*Laphria*) *xylocopiformis*, Walk., the type of the genus, was described from a specimen from Madras, while *H. fera*, v. d. Wulp, occurs in Borneo.

## *Descriptions of new species of South African Rhynchota.* By W. L. Distant.

### Family PYRRHOCORIDÆ.

*Megapetus*, gen. nov.

Head elongately subquadrate, narrowed in front of insertion of antennæ, apex truncately rounded, outer margins of eyes not so wide as posterior angles of pronotum, antennæ four-jointed, simple, second and third joints subequal in length, each shorter than first, fourth much the longest; pronotum with the lateral margins convex, narrowed anteriorly to base of head, lateral angles spinously produced, posterior margin truncate; hemelytra rudimentary; scutellum triangular; abdomen inflated; rostrum reaching the intermediate coxæ, basal joint very robust, subequal to or very slightly shorter than second joint; legs simple, posterior legs much the longest, posterior femora obsoletely spinous before apex.

Allied to *Myrmoplasta*, Gerst.

*Megapetus atratus*, sp. nov. (Pl. XIX, f. 57–58 × 1½.)

Black; antennæ pale fuscous, basal half of first joint greyish, fourth joint dark fuscous; head anteriorly somewhat longly greyishly pilose; in ♂, base of abdomen black with a small whitish spot near each anterior lateral angle, in ♀ base of abdomen brownish;

posterior pronotal angles distinctly spinously produced, the spines directed a little backwardly; the upper surface is very finely and somewhat sparingly pilose; base of anterior tarsi pale fuscous; in ♀ the intermediate tibiæ somewhat brownish.

Long. 8 millim.; exp. pronot. angl. 2½ millim.

*Hab.* MASHONALAND; Salisbury (*G. A. K. Marshall*).

Type in the Hope Museum, Oxford, and in Coll. Distant.

*Dysdercus intermedius*, sp. nov. (Pl. XIX, f. 51.)

Above pale ochraceous; head, anterior area and lateral margins of pronotum, basal area of lateral pronotal margins, scutellum, body beneath rostrum, and legs reddish-ochraceous or pale sanguineous; antennæ, discal narrow transverse fascia to corium, membrane, tibiæ, tarsi, and anterior margins of sternal and abdominal segments, black; anterior margin of pronotum broadly, posterior margin narrowly, anterior and posterior margins of prosternum, lateral and posterior margins of pro- and mesosterna, lateral and posterior margins of abdominal segments and the coxæ, pale luteous; anterior femora spined beneath at apex; second joint of antennæ slightly shorter than the first the base of which is reddish.

Long. 16 to 21 millim.

*Hab.* GERMAN EAST AFRICA (*Capt. Atkinson*—Brit. Mus.). MASHONALAND; Salisbury (*G. A. K. Marshall*).

Type, from German East Africa, in the British Museum. Specimens from Mashonaland in the Hope Museum, Oxford, and in Coll. Distant.

Intermediate between *D. superstitiosus*, Fabr., and *D. cardinalis*, Gerst. From the first it differs by the absence of the black fascia to the posterior margin of the pronotum and the transverse fascia to the corium; from *D. cardinalis* it differs by the black tibiæ and tarsi.

## Family REDUVIIDÆ.

*Phonoctonus formosus*, sp. nov. (Pl. XIX, f. 52.)

Pale luteous; head, anterior lobe of pronotum, rostrum, anterior and intermediate femora, base of posterior femora, and coxæ sanguineous; antennæ, scutellum (excluding apex), an indistinct transverse fascia to corium at and somewhat confused with base of membrane, tibiæ and tarsi, posterior femora, central area of intermediate femora, membrane, and apex of rostrum black; sternum

piceous, lateral and posterior segmental margins, luteous; abdomen beneath luteous, lateral and posterior segmental margins, sanguineous, apex fuscous.

Anterior lobe of pronotum posteriorly sulcate, posterior lobe entire, the last with its anterior lateral margins narrowly black; body beneath, sparingly and finely pilose.

Long. 19 millim.

*Hab.* Angola (Brit. Mus.). Mashonaland: Salisbury (*G. A. K. Marshall*).

Type, from Angola, in the British Museum.

Specimens from Mashonaland in the Hope Museum, Oxford.

*Callilestes stigmatellus*, sp. nov. (Pl. XVIII, f. 62.)

Ochraceous; anterior lobe of pronotum, lateral margins of pro- and mesosterna, the metasternum, and abdomen beneath reddish-ochraceous; antennæ, apex of head, eyes, and a transverse fascia between eyes, a postmedian transverse fascia and the apical angles to corium, membrane, tarsi, and posterior tibiæ black; bases of posterior tibiæ, basal angle and a central spot to membrane, ochraceous.

Anterior and posterior pronotal lobes with a distinct central sulcation, scutellum with a strong, circular, basal foveate impression; posterior lobe of pronotum, scutellum and corium thickly and finely punctate; femora moderately nodulose and with the tibiæ distinctly pilose; hemelytra extending considerably beyond the apex of the abdomen.

Long. incl. membr. 14 millim.

*Hab.* Mashonaland; Salisbury (*G. A. K. Marshall*).

Type in the Hope Museum, Oxford.

*Descriptions of new species of South African Hymenoptera.* By Colonel C. T. Bingham.

*Chalcis bicolor*, sp. nov. (Pl. XXIII, f. 10.)

♂. Head, thorax, the coxæ and trochanters of the anterior, and intermediate, and the upper side of the coxæ, the trochanters, tibiæ and tarsi of the posterior legs black, the femora and tibiæ of the anterior and intermediate legs, the front of the posterior coxæ, the posterior femora and the abdomen orange-yellow, the apex of the mandibles castaneous, the tibial calcaria of the hind-legs yellow.

Head and thorax coarsely closely punctured, cribrate, the wide deep antennal groove on the face, and the mesopleuræ transversely striate, the scutellum broad and convex above, posteriorly bidentate, the postscutellum and median segment shining, the latter areolated and bearing a strong tooth on each side ; legs finely punctured opaque, abdomen smooth and shining. The sides of the broad vertical furrow on the front of the head, the cheeks and the metapleuræ covered densely with long white hairs, the legs and the rest of the head and thorax with sparse shining white pubescence. Wings dark fuscous with a purple iridescence in certain lights.

*Length* ♂ 9 m.m. ; *exp.* 17 m.m.

*Hab.* Salisbury, 5000 feet, MASHONALAND, SOUTH AFRICA.

Bears a superficial resemblance to *C. semirufa*, Walker, from the Oriental Region, but in sculpture and in the distribution of colour widely different.

Type in the Hope Museum, Oxford.

*Iphiaulax ruber*, sp. nov. (Pl. XXIII, f. 31.)

♀. Red, the front below the antennæ, the head above, the cheeks, except a narrow line behind the eyes, the antennæ, the apex of the mandibles and the claws black ; wings fusco-violaceous, the basal three-fourths of the stigma and two obscure spots beneath it on the fore-wing reddish hyaline. Head smooth and shining, a semicircular transverse depression in front of the ocelli. Thorax glabrous, shining ; mesonotum gibbous, the parapsidal grooves indistinct ; the scutellum triangular somewhat laterally compressed, the postscutellum transverse ; the median segment elongate obliquely sloping to the apex not areolated, the pear-shaped stigmata placed in a depression on each side. Head, thorax and legs covered with a fine, short, erect, brownish pubescence. Abdomen somewhat elliptical, as long as the head and thorax united ; basal segment with a raised longitudinal rectangular centre portion smooth and shining, the lateral margins foveate and bounded by a carina, the apex of the raised part depressed, longitudinally striate and margined by a transverse broad carina ; 2nd segment with a medial subtriangular plate smooth and shining from which coarse divergent striæ radiate in the deep depressions on each side, these depressions bounded laterally and posteriorly by raised carinæ ; remaining segments coarsely punctured, rugose, the sutures between the segments 2–5, and oblique lateral grooves on segments 3–5 crenulate.

*Length* ♀ to apex of abdomen 20 ; of ovipositor 22 m.m. ; *exp.* 38 m.m.

*Hab.* Salisbury, 5000 feet, MASHONALAND (*G. A. K. Marshall*).

Type in the Hope Museum, Oxford.

*Phanomeris dubius*, sp. nov. (Pl. XVIII, f. 59.)

♀. Reddish-yellow, the apex of the mandibles, the eyes, the antennæ, a triangular spot enclosing the ocelli, and the ovipositor black, the posterior tibiæ shaded with fuscous black; wings hyaline yellow shaded as follows, fore-wing the stigma jet black, a spot at the apex of the median cell, spreading across the nervure into the 1st discoidal cell, a spot at the base of the 2nd discoidal cell, a bar interrupted below crossing the disc of the wing below the stigma, and the apical margin of the wing fuscous; hind-wing, a spot beyond the transverse nervure closing the median cell, and the apical margin of the wing broadly, fuscous. Head cubical, the front above the antennæ, the vertex, occiput and cheeks smooth and shining, head in front below the antennæ closely and somewhat coarsely punctured rugose. Thorax not broader than the head coarsely but sparingly punctured, the mesonotum gibbous, the parapsidal grooves deep, the scutellum compressed smooth, legs moderately long with the femora and tibiæ incrassate; median segment finely and closely punctured rounded above, and bearing a delicate median longitudinal carina. Abdomen longer than the head and thorax united, elongate oval, the basal two segments finely striate above, the disc of the 2nd segment raised, the raised portion semicircular, the depression on either side of the raised portion above smooth, the suturiform articulation distinct, crenate, the apical segments smooth and shining with transverse impressions at their bases, these latter crenulate. Ovipositor longer than the head and body, the sheath densely pubescent.

*Length* ♀, to apex of abdomen 17 m.m.; ovipositor 26 m.m.; *exp.* 32 m.m.

*Hab.* Salisbury, 5000 feet, MASHONALAND, SOUTH AFRICA (*G. A. K. Marshall*).

It is with much doubt that I record this species under Forster's genus *Phanomeris*. It has the appearance of a *Vipio*, but there are no tufts of hair at the base of the clypeus, the submedian cell in the fore-wing is longer than the median cell, and in the hind-wing the submedian cell is about equal to half the length of the median cell.

Type in the Hope Museum, Oxford.

*Pompilus marshalli*, sp. nov. (Pl. XXIII, f. 20.)

♀. Resembles *P. collaris*, Saussure, from Madagascar, but the thorax is comparatively longer, the scutellum not so raised and prominent, and the median segment is almost cylindrical very convex above, roughly transversely striate, and posteriorly truncate but not concave. In *P. collaris* the median segment is smooth almost flat above, while the posterior face is concave with the sides distinctly produced backwards.

Black with a beautiful purplish bloom on the abdomen above; the head with the mandibles and the scape of the antennæ, the pronotum, the tibiæ and tarsi of the anterior, and the tibiæ and base of the first joint of the tarsi of the intermediate and posterior legs red; wings fusco-violaceous the posterior scarcely lighter in colour than the anterior wings. In *P. collaris* the fore-wing is markedly darker than the hind-wing. Abdomen massive as long as the head and thorax united. Base of the 2nd ventral segment with a distinct transverse groove; pygidial area densely pubescent.

*Length* ♀ 20; *exp.* 28 m.m.

*Hab.* Salisbury, 5000 feet, Mashonaland (*G. A. K. Marshall*).

This species belongs to Kohl's *ferreola* group of *Pompilus*.

Type in the Hope Museum, Oxford.

*Description of a new species of* Carabidæ *from South Africa.* By Guy A. K. Marshall.

*Polyhirma bennettii*, Mshl., sp. nov.

Long. 15 m.m. Length of elytra 8 m.m.; width at base 1·75 before middle 3, at apex 1·75 m.m.

Body depressed and very elongate. Colour black with a broad line of thin greyish pubescence from labrum to basal part of elytra; the foveæ of the elytra filled with ferruginous pubescence, and at the apex an elongate sutural white patch.

*Head* broadly depressed in middle, indistinctly punctured and with a short central carina just behind the labrum, which is bare and impunctate; eyes prominent; the band of pubescence very broad in front, narrow posteriorly. *Antennæ* strongly compressed, black; the three basal joints shiny and with sparse white pubescence

exteriorly ; the remaining points appear dull owing to their being strongly aciculate, except for a narrow smooth central line. *Prothorax* elongate, broadest at apex, sides subparallel nearly to middle and thence strongly narrowed to base. A broad central furrow throughout, containing the pubescent stripe, and a deep short stria on either side of it at base ; punctuation strong, close and even. In the basal portion the lateral part of the thorax is produced so as to extend a good deal beyond the dorsal edge from which it is separated by a very deep incision. The mesonotum is broadly exposed and bears a part of the central pubescent stripe. *Elytra* very narrow and elongate, scarcely broader than the head at their widest part, which is before middle. Sides distinctly rounded, apex broadly truncate. Dorsal surface very much flattened, with six sharp, narrow carinæ (the sutural one not reaching the base) and a very short apical one between the 5th and 6th ; all the carinæ disappear before reaching the apex ; the 6th carinæ form the dorsal edges of the elytra, the portions between them and the true edges being folded over underneath so as to form false epipleura. The spaces between the carinæ are occupied by large reticulate foveæ, filled with ferruginous pubescence, which are largest near the suture and diminish in size laterally. The basal sutural stripe is short, being about as long as the apical white patch ; the latter is narrow and elongate, bifid posteriorly and reaches the extreme apex. *Legs* black with fine white pubescence ; the posterior pairs of femora are more strongly compressed than in any other species of the genus.

This remarkable species was discovered at Somerset West, Cape Colony, in January 1900, by Mr. E. N. Bennett, M.A., Fellow of Hertford College, Oxford, to whom I have dedicated it. Its depressed and narrow form is more suggestive of a subcortical insect than of a terrestrial *Polyhirma*, and the folding under of the elytral margins is a unique character in the genus. The species to which it is most nearly allied is *P. macilenta*, Ol., from which it may at once be distinguished by its very different facies; and it also differs in the following points: (1) the costæ of the elytra are extended further towards the apex (as in *P. semisuturata*, Chd.); (2) the costæ are sharper and straight, not undulating ; (3) the prothorax is not nearly so heart-shaped, owing to the sides not being rounded in front. The last two points, as well as the shortness of the basal stripe on the elytra, distinguish it from *semisuturata*.

The type is in the Hope Museum, Oxford.

## *Description of a new species of* Telephoridæ *from Mashonaland.* By J. Bourgeois.

*Lycocerus mimicus*, sp. nov. (Pl. XVIII, f. 11 ♂, f. 12 ♀.)

Oblongus, subparallelus, niger, pubescens ; capite prothoraceque dense punctulatis, nitidiusculis, hoc antice leviter reflexo-marginato, ad latera incrassato et vage rufo-limbato ; elytris opacis, tomentosis, ruguloso-punctatis, flavo-testaceis, apice nigris, costis duabus obsoletis singulatim notatis ; corpore subtus nitidiusculo, nigro, abdomine lateraliter flavo-marginato ; unguiculis simplicibus, rufis.

♂. Prothorace subelongato, antice rotundato, lateribus parallelis, subrectis, haud marginatis, disco longitudinaliter sulcato ; abdominis segmento ultimo bivalvato, valva inferiori cupuliformi.

♀. Prothorace transverso, antice arcuato, lateribus minus parallelis, anguste submarginatis, sulco dorsali obsoleto ; abdominis segmento ultimo integro, semilunato.

Long. 9–11 mill.

*Hab.* Mashonaland ; Salisbury (*G. A. K. Marshall*). Sex (♂, ♀).

Type in Hope Museum, Oxford.

C'est la première espèce africaine connue du genre *Lycocerus*, Gorham (Proc. Zool. Soc. Lond., 1889, p. 108). De même que ses congénères asiatiques, dont elle diffère surtout par la coloration, elle présente une certaine analogie de facies avec les Lycides du groupe des Calochromides. Chez le ♂, le prothorax est plus etroit et plus allongé que chez la ♀. En outre, dans l'exemplaire que j'ai sous les yeux, le pronotum présente, de chaque côté du milieu et contre le liseré roussàtre qui existe dans les deux sexes, une autre petite tache rousse qui manque dans la ♀. Mais je ne saurais dire si cette particularité de coloration est constante.

## Explanation of Plate IX.

Injuries to wings of South African Butterflies.

Injuries inflicted at the apex or hind margin of one or both fore-wings, or near the overlap of fore- and hind-wings, or at two or more points in the total wing margin.

All the figures are about $\frac{3}{5}$ of the natural size.

All the specimens were captured, on the dates mentioned, at Salisbury, Mashonaland, 5000 feet, by Guy A. K. Marshall.

Fig. 1. *Limnas chrysippus* ♀, Sept. 22, 1900. Very rarely settles on the ground, so that the attacks of lizards are not likely to be common.

2. *Parosmodes icteria*, March 9, 1898. Found in the bush and woodland districts, settling on flowers. Probably injured when flying, as it rests with its wings closed.

3. *Junonia cebrene* ♂, Feb. 15, 1899. Settles on the ground, injuries were very probably inflicted by a lizard.

4. *Acræa anemosa* ♂, March 11, 1899. Flies high for an *Acræa*, and never settles on ground : feeds on tree flowers, and usually at some height. The injury was probably caused by a bird.

5. *L. chrysippus* ♀, March 11, 1898.

6. *Catochrysops mashuna* ♂, Sept. 29, 1900. Flies very rapidly, settles on low flowers and the ground, rests at night on grass-stems. The injury was probably caused by a lizard.

7. *A. anemosa* ♀, Jan. 2, 1899.

8. *Teracolus omphale* ♂, March 31, 1901. Flies rapidly, settles on low flowers and ground, so that lizards are probable enemies, but the narrow symmetrical notch rather suggests a bird's beak.

9. *Atella phalantha* ♂, March 22, 1899. Flies rapidly, settling on bushes and flowers and not on the ground. Birds are the probable enemies.

10. *L. chrysippus* ♀, July 14, 1901.

11. *L. chrysippus* ♀, Jan. 2, 1898. The evidence of crumpling, the scratching of the surface, as well as the extensive injuries point to the probable attack of a mantis.

12. *A. phalantha* ♀, March 5, 1899. Tips of both fore-wings snipped off, probably by a bird.

FIG. 13. *A. nohara*, form *halali*, March 9, 1898. Flies low and settles on low flowers and the ground. A lizard is a probable enemy except that the injury is unilateral and the insect closes its wings in all but the short rests, when it opens and shuts them.

14. *Catopsilia florella* ♀, Dec. 18, 1898. Flies very rapidly, rests on trees under leaves, visits flowers and bushes. It only settles on the ground to drink in damp places. It is unlikely to be attacked by a lizard, and the character of the injury probably indicates a bird.

15. *Precis sesamus* ♀, April 8, 1901. Probably injured by a bird: the notch is too narrow for a lizard. The specimen was evidently freshly emerged.

16. *Terias brigitta* ♀, December 18, 1898. Flies slowly and settles on the ground and low flowers. Probably attacked by lizard.

17. *C. florella* ♂, Jan. 21, 1899. The injury *strongly* suggests the beak of a bird. Both wings are symmetrically snipped.

18. *C. florella* ♂, Jan. 14, 1899. The habits imply that birds are the usual enemies.

19. *P. sesamus* ♂, April 8, 1901. The shape of the tear is such as might have been made by a lizard, and the habits of the butterfly render it quite probable that the injury was thus caused. A very fresh specimen.

20. *Pseudonympha extensa* ♂, Jan. 2, 1899. A woodland species with feeble flight, settling on low flowers and the ground. It was very probably attacked by a lizard.

21. *Terias brigitta* ♂, March 9, 1898. Similar to description of Fig. 16.

22. *Belenois severina* ♂, Jan. 25, 1899. Flight like that of *Teracolus omphale*, see Fig. 8 description. Attack of lizard probable.

23. *Precis archesia* ♂, April 8, 1901. The character of the injury suggests the attack of a bird. Very fresh specimen.

24. *Precis antilope*, form *simia* ♀, Dec. 31, 1898. All *Precis* in woodland and open country settle frequently on rocks and ground. The injury probably caused by a lizard.

25. *B. severina* ♀, Feb. 1, 1899. Probably injured by a lizard.

## Explanation of Plate X.

### Injuries to hind-wings of Mashonaland and Holarctic Butterflies.

Injuries inflicted at the anal angle or hind margin of one or both hind-wings, suggesting that the insect was being pursued or, if settled, approached from behind.

All the figures are ⅔ of the natural size.

All the specimens not otherwise described were captured on the dates mentioned by Guy A. K. Marshall at Salisbury, Mashonaland, 5000 feet.

Fig. 1. *Limnas chrysippus* ♀, July 14, 1901.

2. *Atella phalantha* ♀, Jan. 18, 1899.

3. *Hypolimnas misippus* ♀, April 10, 1898. Flies like its model *chrysippus* until disturbed, when it is swift. Settles on low flowers. Lizards probable enemies. Very fresh specimen.

4. *A. phalantha* ♂, March 26, 1899. Character of injury strongly suggests a bird's beak.

5. *A. phalantha* ♀, Dec. 1900.

6. *Byblia acheloïa* ♂, Feb. 25, 1899. The species of *Byblia* fly low at a medium pace, and settle on [illegible] occasionally on the ground, they rest at night on grass stems. Lizards are probable enemies, but the character of the injury rather suggests a bird.

7. *Acræa rahira* ♀, Dec. 31, 1898. Many insects, settling on flowers in low marshy places where lizards are not often seen, hence birds are more probable enemies. Mr. Marshall noted concerning the specimen here represented, when it was in the fresh state, "judging from the state of the abdomen this insect had been caught and rejected, presumably by a bird."

8. *Nyctemera leuconoë*, April 8, 1901. Never settles on ground. It almost invariably covers its hind-wings directly it settles, assuming a ∧ shape, although it occasionally walks a short distance with its wings erect. The injury was almost certainly inflicted during flight by a bird.

9. *Pyrameis cardui*, var. ♀, Jan. 1900. Often settles on ground. Lizards probable enemies.

10. *Byblia ilithyia* ♂, Jan. 27, 1899.

11. *B. ilithyia* ♂, Feb. 1, 1899.

Fig. 12. *B. acheloïa* ♂, Feb. 22, 1899.

13. *Cyclopides willemi* ♂, March 1, 1899. A woodland insect settling on flowers and never on ground. Rests at night on grass-stems. Probably attacked on the wing, as the injury is unilateral and the butterfly closes its wings when settled.

14. *Pseudonympha vigilans* ♂, March 17, 1901. A rock butterfly, lizards the probable enemies.

15. *Junonia cebrene* ♂, Jan. 14, 1899.

16. „ „ „ Feb. 18, 1899.

17. *C. willemi* ♂, March 11, 1899. If this butterfly was attacked, a bird is the probable enemy.

18. *Herpænia eriphia* ♀, March 9, 1898. Flies slowly and rather low, settling on flowers and the ground like a *Teracolus*. Lizards the probable enemies.

19. *Mylothris rüppelii* ♂, Feb. 1900. Slow flapping flight, settling on flowers and twigs of bushes in exposed positions. The wings are generally open during a short rest. The hind-wing was probably shorn through by a bird.

20. *Terias senegalensis* ♂, Jan. 21, 1899.

21. *T. regularis* ♀, May 24, 1901.

22. *Belenois severina* ♀, Jan. 25, 1899.

23. „ „ ♂, Feb. 15, 1899.

24. *Catopsilia florella* ♂, Dec. 18, 1898.

25. *Teracolus achine* ♂, April 16, 1899.

26. *Argynnis cybele*, Aug. 2, 1897. Captured by E. B. Poulton, near North Lake, Hartland, Wis., U.S.A. A flower-haunting fritillary very probably injured by a bird.

27. *B. severina* ♂, Feb. 15, 1899.

28. *Epinephele janira* ♀, Aug. 15, 1900. Captured by A. H. Hamm, near Dawlish, S. Devon. Both hind-wings probably shorn through by a bird; lizards are not important enemies in this country. The straight line of the injury also suggests a bird's beak.

29. *Melanargia galathea*, July 21, 1898. Captured by E. B. Poulton on the Stalden Rd., near Visp, Valais, about 2300 feet. The injury might well be by a lizard, but in Europe they are not nearly such important enemies as they become further south.

30. *Lycæna icarus*, July 26, 1898. Captured by E. B. Poulton at Creux de Genthod, N.W. shore of the Lake of Geneva, 1230 feet. The character of the injury clearly suggests a bird.

Fig. 31. *Vanessa atalanta* ♂, Aug. 23, 1897. Captured by F. A. Dixey at Morthoe, N. Devon. The injury can hardly have been produced otherwise than by a bird snipping a notch in all four wings when they come together in the attitude of repose as shown in the figure.

32. *Epinephele lycaon*, July 22, 1898. Captured by E. B. Poulton between Visp and Stalden, Valais, about 2450 feet. The same conclusion as in the description of Fig. 29.

33. *Vanessa atalanta* ♂, Sept. 23, 1901. Captured by A. H. Hamm in the University Parks, Oxford. The character of the injury implies an attack by a bird, probably made in one of the short rests when the insect assumed the attitude shown in the figure.

## Explanation of Plate XI.

### Injuries to directive marks and structures on the wings of South African Butterflies.

Injuries inflicted in the neighbourhood of special marks or structures near the anal angle of hind-wing or apex of the fore-wing.

All the figures are about $\frac{3}{5}$ of the natural size.

All the specimens not otherwise described were captured, on the dates mentioned, at Salisbury, Mashonaland, 5000 feet, by Guy A. K. Marshall.

Fig. 1. *Precis antilope* ♂, May 19, 1898. Rests on leaves of low herbage and rarely on the ground. Birds are the most likely enemies, and the specimen was probably at rest when both "tails" were shorn off.

2. *Precis cuama* ♀, May 1900. Same habit and conclusions as in the last figure.

3. *Spindasis natalensis*, June 13, 1900. Captured by Champion B. Russell near Eshowe, Zululand. Flight very rapid, settles on outer leaves of trees and never on ground. Almost certainly injured by a bird.

4. *Precis archesia* ♂, March 9, 1901. This unilateral injury was probably inflicted on the wing.

5. *Charaxes guderiana* ♂, Dec. 31, 1898. All *Charaxes* here represented fly and settle like *S. natalensis*. Birds by

far the most probable enemies unless there is evidence of the attacks of a mantis (possible but not likely in the example represented in this figure).

Fig. 6. *Tarucus plinius* ♂, March 11, 1899. Flies at medium pace, settles on bushes and low trees, birds the probable enemies. The injury moreover suggests a bird.

7. *Hypolycæna philippus* ♂, March 11, 1899. Habits and conclusions as in the last figure. These two Lycænids and many other butterflies will settle on the ground in damp spots to drink, but Mr. Marshall has not seen lizards in such places.

8. *Papilio demodocus* ♂, March 2, 1901. Flies rapidly, settling on flowering bushes; probable enemies mantides or birds; lizards improbable. Character of injury suggests posterior part of both hind-wings shorn off while at rest by a bird.

9. *P. demodocus* ♂, Jan. 24, 1901. Same conclusion as in last figure.

10. *Charaxes achæmenes* ♀, March 6, 1898. See description of Fig. 5.

11. *Catochrysops parsimon* ♀, Jan. 25, 1899. Very rapid flight, settling on ground and low veldt flowers and at night resting on grass-stems. Lizards probable enemies, but the character of the injury suggests a bird.

12. *Axiocerces harpax* ♂, March 3, 1899. Habits and conclusions as in Figs. 6 and 7.

13. *Charaxes saturnus* ♂, March 6, 1898.

14. „ „ „ March 12, 1898.

15. *C. guderiana* ♀, March 6, 1898. In this and the two preceding figures, see description of Fig. 5.

16. *Uranothauma poggei* ♂, Jan. 1901. A woodland species flying at medium pace and settling on low flowers. Birds probable enemies.

17. *T. plinius* ♀, March 11, 1899. Injury suggests bird. Probably seized on the wing.

18. *Axiocerces amanga* ♂, Dec. 27, 1900. Habits and conclusions as in Figs. 6 and 7. Probably seized at rest with wings closed.

19. *H. philippus* ♂, March 11, 1899. Injury suggests bird. Probably attacked at rest.

20. *C. saturnus* ♂, Jan. 2, 1899. Symmetry of injury suggests conclusions as in Figs. 8 and 9.

21. *Teracolus achine* ♂, April 9, 1899.

22. „ „ „ April 2, 1899.

Fig. 23. *Teracolus achine* ♀, March 11, 1899. In this and the two preceding figures the unilateral injury suggests an attack on the wing.

24. *Pyrameis cardui* ♂, Dec. 31, 1898.

## Explanation of Plate XII.

### Seasonal Phases of Butterflies of the Genus Precis.

Representation of parent and offspring in *Precis sesamus* and *P. antilope*.

Demonstration of the seasonal phases of South African Butterflies of the genus *Precis*.

All the figures are about $\frac{9}{10}$ of the natural size.

All the specimens represented were captured or bred by Guy A. K. Marshall.

Fig. 1. *Precis sesamus*, form *natalensis* ♀, Salisbury, 5000 feet, captured Feb. 27, 1898, after it had laid three eggs. Parent of butterflies represented in Figs. 1*a* and 1*b*.

1*a*. *Precis sesamus* ♂, offspring No. 1 of butterfly represented in Fig. 1. Egg laid Feb. 27, hatched March 5, larva pupated March 31, imago emerged April 15.

1*b*. *Precis sesamus*, form *natalensis* ♀, offspring No. 2 of butterfly represented in Fig. 1. Egg laid Feb. 27, hatched March 5, larva pupated April 5, imago emerged April 20. A distinctly dark individual showing some slight tendency towards *sesamus*, especially in the width of the black margin of the hind-wings and the size of the blue spots in this margin.

These two offspring show the overlap of summer and winter phases remarkably well. The summer form, Fig. 1*b*, even appeared a few days later in the beginning of winter than the winter form, Fig. 1*a*. At the same time the former is unusually dark.

2. *Precis sesamus*, form *natalensis* ♀, Salisbury, 5000 feet, captured March 6, 1898, after it had laid one egg. Parent of butterfly represented in Fig. 2*a*.

2*a*. *Precis sesamus* ♂, offspring of butterfly represented in Fig. 2. Egg laid March 6, hatched March 12, larva pupated April 7, imago emerged April 30. The last part of larval

life and the first part of pupal were passed in a damp jar (March 30 to April 5). The imago is nevertheless a characteristic example of the dry phase.

Fig. 3. *Precis antilope* ♀, form *simia*, Salisbury, 5000 feet, captured Feb. 23, 1902, after it had laid eleven eggs. Parent of butterflies represented in Figs 3*a* and 3*b*. The under-side is shown on Plate XIII, fig. 4.

3*a*. *Precis antilope* ♀, offspring No. 1 of butterfly represented in Fig. 3. Egg laid Feb. 23, hatched March 1, larva pupated April 10, imago emerged April 27. The under-side is shown on Plate XIII, fig. 4*a*.

3*b*. *Precis antilope* ♂, offspring No. 2 of butterfly represented in Fig. 3. Egg laid Feb. 23, hatched March 1, larva pupated April 14, imago emerged April 29. The under-side is shown on Plate XIII, fig. 4*b*.

4. *Precis archesia* ♀, captured Oct. 7, 1897, at Malvern, 800 feet, near Durban, Natal. This insect was *in coitu* with the form represented in Fig. 5.

5. *Precis archesia* ♂, a form varying somewhat distinctly in the direction of the wet phase (*pelasgis*), captured *in coitu* with the insect represented in Fig. 4. The tendency towards *pelasgis* is better shown upon the under-side, Plate XIII, fig. 8.

## Explanation of Plate XIII.

### Seasonal Phases of Butterflies of the Genus Precis.

Under-sides of seasonal phases of *Precis sesamus*, *P. antilope*, and *P. archesia*, including those of *P. antilope* and its two offspring shown on Plate XII.

All the figures are about $\frac{9}{10}$ of the natural size.

All the specimens not otherwise described were captured by Guy A. K. Marshall.

Fig. 1. *Precis sesamus*, form *natalensis* ♀, under-side of wings; Salisbury, 5000 feet, captured Feb. 20, 1898. Comparing this with Figs. 1, 1*b*, and 2 on Plate XII, it is seen that the under-side, although very similar to the upper, is even more conspicuous than it. The difference is brought about by the pale spots on the black basal patch of the

hind-wings and the more distinct white markings in the black marginal band, on the under-side; also by the paler tint of the ground-colour, making a stronger contrast with the black markings.

Fig. 2. *Precis sesamus* ♀, under-side of wings; Salisbury, 5000 feet, captured April 2, 1898. Even in the absence of colour the astounding difference between this and the wet-season phase (see Fig. 1) is clearly shown.

3. *Precis sesamus*, form *natalensis* ♂, strongly tending towards the dry phase, under-side of wings; Machakos, British East Africa, captured June 6, 1900, by Mr. and Mrs. S. L. Hinde. This beautiful variety stands well on the wet, or red, side of intermediate.

4. *Precis antilope*, form *simia* ♀, under-side of wings; Salisbury, Feb. 23, 1902. Parent of butterflies represented in Figs. 4*a* and 4*b*. This figure shows the under-side of the specimen represented in Fig. 3, Plate XII. It is seen that the under-side is much more conspicuous than the upper in the points mentioned above in the description of *P. sesamus*, form *natalensis* (Fig. 1); especially in the far greater contrast between the lighter ground-colour and the black markings and in the amount of white in the black border.

4*a*. *Precis antilope* ♀, under-side of wings. Offspring No. 1 of butterfly represented in Fig. 4. This figure shows the under-side of the butterfly represented in Fig. 3*a*, Plate XII. The difference between the under-side in offspring and parent is as astonishing as in the two phases of *sesamus*, while the difference in shape of the wings is even more remarkable.

4*b*. *Precis antilope* ♂, under-side of wings. Offspring No. 2 of butterfly represented in Fig. 4. This figure shows the under-side of the butterfly represented in Fig. 3*b*, Plate XII. The great difference in the character of the under-side in the two offspring (compare this figure with the preceding) is well shown, although both represent dead leaves equally well.

5. *Precis archesia*, form *pelasgis* ♂, under-side of wings; Salisbury, 5000 feet, captured Dec. 11, 1897. The figure shows well that the difference between the two phases of this species is far more important upon the under- than the upper-side. It is also seen that the pale, conspicuous, sharply-outlined, black-spotted band of the wet phase represents the intensely cryptic mid-rib-like streak of the

dry phase (compare this figure with Figs. 6, 7, and the somewhat intermediate Fig. 8).

Fig. 6. *Precis archesia* ♂, under-side of wings ; Salisbury, 5000 feet, captured April 30, 1899. The mottled browns and greys of the under-side are very markedly different from the uniform dark brown of the wet phase. Great variation in these mottled tints occurs in different individuals, harmonizing with the varied appearance of rocks, being at the same time dead-leaf-like.

7. *Precis archesia* ♀, under-side of wings ; Berea, near Durban, Natal, captured April 5, 1896, by Mr. D. Chaplin. In this variety of *archesia* the ground-colour is comparatively unmottled, and to this extent transitional towards the *pelasgis* form. This difference upon the under-side corresponds with a slight approach in the same direction on the upper-side, where the deep red-brown band is broader and more continuous than is usual in typical *archesia*.

8. *Precis archesia* ♂, under-side of wings ; variety distinctly transitional towards the *pelasgis* (wet) phase ; Malvern, 800 feet, near Durban, Natal. This specimen was captured *in coitu* with a ♀ of typical *pelasgis*, Oct. 7, 1897. The intermediate character is seen in the conspicuous broad light band as well as in the unmottled ground-colour. Comparing this with Figs. 5 and 6, it is seen that in spite of this distinct tendency towards *pelasgis*, the specimen represented in Fig. 8 is still well on the *archesia* side of intermediate, and would doubtless be well concealed with its wings closed. The character of the surface of both wings outside the broad band is especially unlike *pelasgis*, as is the gradual transition of the outer border of the band itself into the ground-colour. The upper-side of the specimen here represented is shown on Plate XII, fig. 5, and that of the ♀ *pelasgis* with which it was *in coitu* on Plate XII, fig. 4.

## Explanation of Plate XIV.

### Mimicry in Mashonaland Butterflies.

Acræine and Lycænid mimics of *Limnas chrysippus*. Incipient mimicry of Acræas by *Lycænidæ* and *Hesperidæ*.

All the figures are about $\frac{9}{10}$ of the natural size.

All the specimens figured on this plate were captured by Guy A. K. Marshall in Mashonaland.

Fig. 1. *Limnas chrysippus* ♀, April 9, 1899. Captured together with the specimens represented in Figs. 1*a*, 2, and 2*a* at Salisbury (5000 feet). The specimen is rather small; the ground-colour is of the dark-brown shade characteristic of the Ethiopian Region.

1*a*. *L. chrysippus*, under-side ♂. The peculiar shade of the apex of the fore-wing beyond the sub-apical white bar much resembles the ground-colour of the hind-wing, but is distinguished from it by a faint greenish-orange tinge. It is seen to be mimicked in the under-side of *Mimacræa marshalli* (Fig. 2*a*), and less perfectly in that of *Acræa encedon* (Fig. 3*a*).

2. *Mimacræa marshalli* ♂. A beautiful mimic of *chrysippus* (compare Fig. 1). The shape of the sub-apical white bar however more strongly suggests that of *Acræa encedon* (Fig. 3).

2*a*. *M. marshalli*, under-side ♂. The spots at the base of the hind-wing as well as the shape of the sub-apical bar suggest *encedon* rather than *chrysippus* (compare Fig. 3*a*), although the mimicry of the latter is strong and evident.

3. *Acræa encedon* ♂, Dec. 1900. Captured together with the specimens represented in Figs. 3*a*, 4, 6, and 7 at Umtali (3700 feet). This, the typical form of the species, is seen to be synaposematic with *chrysippus*.

3*a*. *A. encedon*, under-side ♂. The under-side is seen to be synaposematic as well as the upper.

4. *Catochrysops peculiaris*, under-side ♂. The figure well shows incipient mimicry of the black-spotted under-side of an *Acræa*.

5. *C. mashuna*, under-side ♀, Nov. 7, 1897. Captured at the Umcheki River (4200 feet). The resemblance to an *Acræa* is closer in this species than in the

last, because of the pale tawny ground-colour of the under-side.

Fig. 6. *Abantis tettensis*, under-side. The under-side of the hind-wings shows strong mimicry of an Acræoid type.

7. *Kedestes macomo*, var., under-side. The under-side generally shows the incipient mimicry of an Acræoid type.

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## Explanation of Plate XV.

British East African Butterflies Mimicking L. chrysippus.

Acræine and Lycænid mimics of *Limnas chrysippus* form *klugii* in British East Africa. Varieties of *Acræa encedon* chiefly transitional towards the form *daira*.

All the figures are about $\frac{9}{10}$ of the natural size.

Fig. 1. *Limnas chrysippus*, form *klugii* ♂, May 22, 1900. Captured by Mr. and Mrs. S. L. Hinde, at Machakos Road, British East Africa (about 5400 feet). Very faint traces of the sub-apical white band of *chrysippus* can be detected.

1*a*. *L. chrysippus*, form *klugii*, under-side ♀, Oct., Nov. 1900. Collected by W. Doherty on the Kikuyu Escarpment, British East Africa (6500 to 9000 feet). Distinct traces of the sub-apical white band of *chrysippus* can be seen. Compare Fig. 1*a*, Plate XIV.

2. *Mimacræa dohertyi* ♀, Oct., Nov. 1900. Collected in the same locality as Fig. 1*a*, by W. Doherty. The position and outline of the costal part of the sub-apical white bar of *M. marshalli* can be distinctly traced in the contour of the black markings, although the bar itself is only very faintly paler than the fulvous ground-colour of the wing. Compare Fig. 2, Plate XIV.

2*a*. *M. dohertyi*, under-side ♂, Oct., Nov. 1900. Collected in the same locality as Fig. 1*a*, by W. Doherty. Traces of position of white bar as in upper-side; compare Fig 2*a*, Plate XIV. The black spots on the under-side of the under-wing resemble *Acræa encedon* (Fig. 3*a*) rather than the Danaine model of both insects (Fig. 1*a*).

3. *Acræa encedon*, form *daira* ♂, June 6, 1900. Captured by Mr. and Mrs. S. L. Hinde, at Machakos, British East Africa (about 5400 feet). Faint traces of the sub-apical

white bar of fore-wing although the black ground-colour of the apex is almost absent. Compare Figs. 4–7 and Fig. 3, Plate XIV.

Fig. 3*a*. *A. encedon*, form *daira*, under-side ♂, Oct., Nov. 1900. Collected in the same locality as Fig. 1*a*, by W. Doherty. The under-side shows the same faint traces of the sub-apical white bar as the upper-side. Compare Fig. 3.

4. *A. encedon*, form *daira* ♂, Jan. 28, 1909. Captured by Mr. and Mrs. S. L. Hinde at Kitui, British East Africa (about 4000 feet). The sub-apical bar is rather more distinct and the surrounding ground-colour rather darker than in Fig. 3.

5. *A. encedon*, intermediate between form *daira* and *encedon* ♂, May 18, 1900. Captured by Mrs. Leakey at Ndeje, Bulemezi, near Mengo, Uganda. In this interesting variety the sub-apical bar is very clearly defined by the greatly increased darkness of the adjacent ground-colour, and thus becomes very distinct, although it is itself of a darker shade than any of the specimens represented in the three previous figures (3, 3*a*, and 4).

6. *A. encedon* tending towards the form *daira* in the darkness of the sub-apical bar, and towards the form *alcippina* in the whiteness of the inner part of the hind-wing ♂, May 19, 1900. Captured by Mrs. Leakey in the locality described in Fig. 5. The apex of the fore-wing would be that of typical *encedon* but for the darkness of the bar. It is noteworthy that the costal spot of the bar is much lighter than any of the other four component spots. On the under-side of this specimen the bar is much lighter, although not so white as in typical *encedon*.

7. *A. encedon*, form *alcippina* ♂, Feb. 27 to March 2, 1900. Captured by Mrs. Leakey in the locality described in Fig. 5. With white, conspicuous hind-wings this variety closely resembles the form *alcippus* of *Limnas chrysippus*. The fore-wings are as in typical *encedon* except that they are somewhat darker than usual, suggesting, in the inner contour of the black patch, an approach towards the form *lycia*.

## Explanation of Plate XVI.

Common Warning Colours of Mashonaland Acræine Butterflies, etc.

All the figures are about $\frac{2}{3}$ of the natural size.

All the specimens represented on this Plate were captured by Guy A. K. Marshall at Salisbury, Mashonaland, 5000 feet.

Fig. 1. *Acræa doubledayi*, form *axina* ♂, Dec. 31, 1898.
2. „ „ „ „ ♀ „ „ „
3. „ *caldarena* ♂, Dec. 31, 1898.
4. „ „ ♀ „ „ „
5. „ *nohara*, form *halali* ♂, Dec. 31, 1898.
6. „ „ „ „ ♀ „ „ „
7. „ *rahira* ♂, Dec. 31, 1898.
8. „ „ ♀ „ „ „
9. „ *violarum*, form *asema* ♀, Dec. 31, 1898.

The above five species were therefore captured on the same day in the same place together with other examples of all species except *rahira*, as described on p. 492. The group is a beautiful example of synaposematic (Müllerian) resemblance between the species of a specially-protected group inhabiting the same locality.

10. *A. anemosa* ♀, Jan. 7, 1899.
11. *A. natalica*, ♀ „ „

A male of *anemosa* and a second female of *natalica* were captured on the same day. Another beautiful example of synaposematic resemblance between two fine species.

12. *A. doubledayi*, form *axina* ♂, April 6, 1898.
13. *Baoris netopha* ♀, April 6, 1898.

The Hesperid at rest with its wings closed is a mimic of the smaller Acræas such as that shown in Fig. 12. There are several white spots on both upper- and under-side of the fore-wing of the skipper, but these are concealed by the hind-wing in the position of rest with the fore-wings pressed well back between the hind. In the specimen figured the fore-wings are not quite sufficiently far back, so that the border of the dark shade which should be entirely concealed is exposed together with a part of the most anteriorly-placed white spot.

## Explanation of Plate XVII.

### Mimicry and Warning Colours in Coleoptera.

Mutilloid Coleoptera: *Cleridæ*, *Carabidæ* and *Cicindelidæ*. Warning patterns in the Carabid genus *Anthia*.

All the figures are about $\frac{2}{3}$ of the natural size.

All the specimens, not otherwise described, were captured at the times mentioned, at Salisbury, Mashonaland, 5000 feet, by Guy A. K. Marshall.

Fig. 1. *Mutilla purpurata* ♂, Nov. 1898.
2. „ *tettensis* ♀ „ „
3. „ *cepheus* ♀ „ „
4. „ *leucopyga*? ♀ „ „
5. „ *sycoræ* ♀ „ „
6. „ *horrida* ♀ „ „ to Jan. 1899.
7. *Atractonota mulsanti* „ „ Mimic of ant.
8. „ „ „ „ „ „
9. *Polyhirma ænigma* „ „ „ „ and yet Mutilloid also.
10. *Polyhirma ænigma* „ „ to Jan. 1899. Mimic of large ant, and yet Mutilloid also.
11. *Eccoptoptera cupricollis*, Nov. 1898. A very perfect mimic of a *Mutilla*.
12. *Graptoclerus* sp., Nov. 1898. Mutilloid mimic.
13. *Polyhirma boucardi*, Nov. 1898 to Jan. 1899.
14. *Graphipterus antiokanus*, Nov. 1898 to Jan. 1899. Resembles the much larger Fig. 15, and, like it, Mutilloid.
15. *Piezia selousi*, Nov. 1898.
16. *Polyhirma bilunata*, Nov. 1898 to Jan. 1899. This and the last species, when running, bear a general resemblance to Mutillids.
17. *Myrmecoptera marshalli*, Nov. 1898.
18. „ *invicta* „ „
19. „ *bilunata* „ „ This and the two previous species are mimics of Figs. 15, 16, etc.
20. *Myrmecoptera polyhirmoides*, var. *mashuna*, Nov. 1898 to Jan. 1899. A mimic of Fig. 13.
21. *Anthia massilicata*, Nov. 1898 to Jan. 1899.
22. „ *petersi* „ „ „ „
23. „ *thoracica* „ „ „ „

Fig. 24. *Anthia sexguttata* ♀. Collected by Maj.-Gen. Hearsey, India.
25. *Anthia nimrod* ♀. West Africa.
26. „ *omoplata*, var. *mellyi*, Nov. 1898 to Jan. 1899.

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## Explanation of Plate XVIII.

### Mimicry in Mashonaland Insects.

Mashonaland insects of many Orders with Lycoid pattern and colouring: small groups probably mimetic of Ichneumonids.

All the figures are of the natural size.

All the specimens were captured by Guy A. K. Marshall, at the times mentioned, and unless otherwise described, at Salisbury, Mashonaland, 5000 feet.

Figs. 1 to 52 show a large and complex group, including species of the genus *Lycus* and insects of various Orders and numerous families mimetic of, or converging towards, the orange and black coloration of this abundant and distasteful genus.

Fig. 1. *Lycus* (*Merolycus*) *rostratus* ♂, Jan. 1899.
2. „ „ „ ♀ „ „
3. „ (*Acantholycus*) *constrictus* ♂, Jan. 1899.
4. „ *ampliatus* ♂, June 1900.
5. „ „ ♀, Jan. 1899.
6. „ (*Lopholycus*) *zonatus* ♀, Jan. 1899.
7. „ (*Lopholycus*) *haagi* ♂ „ „
8. „ „ „ ♀ „ „
9. „ (*Chlamydolycus*) *subtrabeatus* ♂, Jan. 1899.
10. „ „ „ ♀ „ „
11. *Lycocerus mimicus* ♂, Nov. 1899.
12. „ „ ♀, Jan. 1899.
13. *Prionocerus dimidiatus*, Jan. 1899.
14. *Pœcilomorpha fasciaticollis*, Nov. 1900.
15. *Peploptera zambesiana*, Jan. 1899.
16. *Diacantha conifera* ♀, Nov. 1898.
17. „ „ ♂, Jan. 1899.
18. *Aphodius holubi*, Feb. 1899.
19. *Eutrapela* sp., Dec. 1901. Mt. Chirinda, Gazaland.
20. *Eletica rufa* ♂, Nov. 1898.
21. „ „ ♀ Jan. 1899.
22. *Mylabris palliata* „ „

Fig. 23. *Zonitis* sp. Jan. 1899.
24. *Blepisanis haroldi* „ „
25. *Amphidesmus analis* „ „
26. *Philagathes lætus* ♂ „ „
27. „ „ ♀, Jan. 1902.
28. *Nitocris* sp., Feb. 1900.
29. „ *nigricornis*? Dec. 1897.
30. „ *similis*, Jan. 1901.
31. *Vitumnus scenicus*, var. *cinnabarinus*, Stål., Jan. 1899.
32. „ „ „ *miniatus*, Stål., Dec. 1900.
33. *Serinetha mutilata*, April 1900.
34. *Lygæus furcatus* „ „
35. *Oncopeltus famelicus*, var. *jucundus*, Sept. 1900.
36. *Pompilus morosus* ♀, Jan. 1900.
Asclepiad pollen masses are seen on the fore tarsi of both sides.
37. *Pompilus capensis* ♀, Jan. 1899.
38. „ *diversus* ♀ „ „
39. „ *vindex*, April 1900.
40. *Cerceris orientalis*, var. ♀, Jan. 1899.
41. *Notogonia cræsus* ♀, April 1900.
42. *Rhynchium radiale* ♀, Jan. 1899.
43. „ *rubens* ♀, Jan. 1900.
44. *Phanomeris* sp.? ♀, Jan. 1901.
45. „ „ ♂, Feb. 1900.
46. *Iphiaulax bicolor* ♀, Sept. 1900.
47. *Bracon luctuosus* ♀, Aug. 1900.
48. „ ?*luctuosus* ♂, Jan. 1902.
49. *Xiphocerus cruciger*, Jan. 1899.
50. *Ilema elegans*, April 1900.
51. *Zygænid* (*gen. indet.*). Mt. Chirinda, 4500 feet, Mashonaland, Dec. 1901.
52. *Neurosymploca ochreipennis*, April 1900.
Figs. 53 to 58 show the mimicry of three convergent and common Braconids by a Reduviid and a Longicorn.
53. *Bracon coccineum* ♀, Aug. 1900.
54. „ „ ♂, Nov. 1900.
55. *Iphiaulax pictus* ♀, Aug. 1900.
56. „ *flagrator* ♀, Jan. 1899.
57. *Oberea scutellaris*, Jan. 1899.
58. *Callilestes bicolor* „ „
The remaining figures exhibit a beautiful case of mimicry by a Reduviid of Synaposematic conspicuously marked parasitic Hymenoptera.

Fig. 59. *Phanomeris dubius* ♀, Nov. 1900.
60. *Pimpla tuberata* ♂, April 1900.
61. „ „ ♀, Nov. 1900.
62. *Callilestes stigmatellus*, Nov. 1900.

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## Explanation of Plate XIX.

Müllerian Mimicry in groups of South African Coleoptera and Hemiptera, etc.

Figs. 30 to 38 twice the natural size; Figs. 53 to 59 one and a half times natural size; all other figures of the natural size.

All the specimens, except that shown in Fig. 16, were captured by Guy A. K. Marshall, and all, unless otherwise stated, are from Salisbury, Mashonaland, 5000 feet.

Figs. 1 to 16 represent a powerful group of *Cantharidæ* and the insects convergent towards them, and having conspicuous cream, orange or red bands on a black ground. The group gradually merges into that shown in Figs. 17 to 29, in which the ground-colour is orange or yellow with black bands, sometimes broken up into spots.

Fig. 1. *Mylabris dicincta*, Dec. 1898.
2. „ *tettensis*, Nov. 1898 to Jan. 1899.
3. „ „ Dec. 1898.
4. „ *tricolor*, Nov. 1898 to Jan. 1899.
5. „ *oculata* „ „ „
6. „ „ Dec. 1898.
7. *Actenodia chrysomelina*, Dec. 1898.
8. „ „ Nov. 1898.
9. *Mylabris holosericea*, Dec. 1898.
10. *Decatoma lunata*, Nov. 1898 to Jan. 1899.
11. *Actenodia chrysomelina*, Dec. 1900.
12. *Decatoma lunata*, var., Nov. 1898 to Jan. 1899.
13. *Mylabris oculata* „ „ „ „
14. *Cymatura bifasciata*, Dec. 1898.
15. *Ceroplesis caffer*, Dec. 1898.
16. *Anubis mellyi*, Colenso, Natal.
17. *Oncopeltus famelicus*, Sept. 1900.
18. *Melitonoma* n. sp., Dec. 1898.
19. „ *truncatifrons*, Oct. 1901.
20. *Clythra wahlbergi*, Dec. 1898.
21. *Melitonoma litigiosa*, Jan. 1901.

Fig. 22. *Antipus rufus* ♀, Oct. 1901.
23. *Melitonoma epistomalis*, Oct. 1901.
24. *Clythra lacordairei*, Oct. 1901.
25. *Antipus rufus* ♀, Feb. 1899.
26. *Aulacophora festiva*, Oct. 1901.
27. *Cryptocephalus quinqueplagiatus*, Dec. 1900.
28. „ *varioplagiatus*, Oct. 1901.
29. *Syagrus marshalli*, Sept. 1900.

Figs. 30 to 38 show a very well-defined group of small Coleoptera in which the head and thorax are bright red and elytra creamy-white with transverse black bands or spots.

30. *Platyxantha bicincta*, × 2, Jan. 1899.
31. *Gynandrophthalma posticalis* ♀, × 2, Feb. 1899.
32. *Monolepta vincta* ♀, × 2, Jan. 1899.
33. *Crioceris coronata* „ „ „
34. *Paralepta ornata* „ „ „
35. *Asbecesta* „ „ „ „
36. *Urodactylus* sp. ♂ „ „ „
37. „ „ ♀ „ „ „
38. *Apoderus gentilis* „ Nov. 1898.

Figs. 39 to 42 show a convergent group of an Hemipteron and two Coccinellids with the characteristic red or yellow and black spotted coloration of the latter family.

39. *Steganocerus multipunctatus*, Feb. 1899.
40. *Epilachna dregei*, Nov. 1898.
41. „ „ Feb. 1899.
42. *Chilomenes lunata*, Feb. 1899.

Figs. 43 to 47 represent a convergent group of red and black coloured Hemiptera—a Reduviid mimicking Lygæids.

43. *Reduvius* sp., Jan. 1900.
44. *Lygæus rivularis*, Nov. 1899.
45. *Graphostethus servus*, Feb. 1900.
46. *Lygæus elegans*, Feb. 1900.
47. „ *crudelis*, Jan. 1900.

Another Hemipterous group showing Reduviids mimicking Pyrrhocorids is shown in Figs. 48 to 52.

48. *Phonoctonus nigro-fasciatus*, Oct. 1897, Malvern, near Durban, Natal.
49. *Dysdercus nigro-fasciatus*, Oct. 1897, Malvern, near Durban, Natal.
50. *Dysdercus superstitiosus*, April 1900.
51. „ *intermedius*, Feb. 1900.
52. *Phonoctonus formosus*, Feb. 1900.

The remaining figures represent a group containing a Locustid and an Hemipteron mimetic of ants.

Fig. 53. *Camponotus* sp.? ☿ × 1½, Feb. 17, 1901.
54. „ *sericeus*, ☿ × 1½, Feb. 17, 1901.
55. „ *cosmicus*, ☿ min. × 1½, Feb. 17, 1901.
56. „ „ ☿ maj. „ „ „
57. *Megapetus atratus*, × 1½, Feb. 17, 1901.
58. „ „ „ „ „
59. *Myrmecophana? fallax*, × 1½, Feb. 17, 1901.

## Explanation of Plate XX.

Group of black, dark-winged Mashonaland Aculeates and their Mimics.

First Part of Group.

The Aculeates with one exception all Fossores.

All the figures are about ½ of the natural size.

All the specimens were captured by Guy A. K. Marshall, at Salisbury, Mashonaland, 5000 feet.

Fig. 1. *Mutilla atropos* ♂, Nov. 1899.
2. *Tiphia rugosa* ♀, Feb. 1899.
3. *Elis lachesis* ♀, April 1900.
4. „ *fasciatipennis* ♀, April 1900.
5. „ „ ♀, Feb. „
6. *Scolia alaris* ♂, April 1900.
7. „ „ ♀, Mar. „
8. „ „ ♀, April „
9. „ *fraterna* ♂, Jan. „
10. „ „ ♀, April „
11. „ *cyanea* ♂, Jan. „
12. „ „ ♀, Mar. „
13. „ *affinis* ♂, June „
14. *Salius atropos* ♀, Mar. „
15. „ *vindex* ♀, Nov. 1899.
16. „ *dedjax* ♂, Feb. 1899 to Jan. 1900.
17. „ *regina* ♂, Feb. 1899.
18. „ *obscurus* ♀, Dec. 1899.
19. *Pompilus sepulchralis* ♀, April 1900.
20. „ *frustratus* ♀, Nov. 1899.

Fig. 21. *Orectocera* (*Paraphania*) *diabolus*, Feb. 1900.
22. *Exoprosopa umbrosa*, Feb. 1900.
23. *Orectocera* (*Paraphania*) *diabolus*, Jan. 1900.
24. *Tabanus*, very near *biguttatus*, Dec. 1900.
25. *Tascia homochroa*, Dec. 1900.
26. *Reduvius*, sp., April 1900.
27. *Harpactor tristis*, April 1900.

## Explanation of Plate XXI.

Group of black, dark-winged Mashonaland Aculeates chiefly Fossores, and their Mimics, etc.

Second Part of Group, chiefly Fossores.

All the figures are about $\frac{4}{5}$ of the natural size.

All the specimens were captured by Guy A. K. Marshall, at Salisbury, Mashonaland, 5000 feet.

Fig. 1. *Sphex bohemani* ♀, Dec. 1899.
2. „ „ ♂, Jan. 1900.
3. „ *cyaniventris* ♂, Nov. 1899.
4. „ *pelopeiformis* ♂, Jan. 1900.
5. „ „ ♀, June „
6. „ *xanthocerus* ♀, Dec. 1899. An Asclepiad pollen-mass is seen on distal end of the left anterior leg.
7. *Sphex umbrosus* ♀, May 1900.
8. *Sceliphron chalybeum* ♂, Feb. 1900.
9. *Tachytes natalensis* ♂, Jan. 1900.
10. „ „ ♀, Dec. 1899.
11. *Ammophila ludovicus* ♀, Feb. 1899 to Jan. 1900. Asclepiad pollen-masses are thickly crowded on the tarsi of the two anterior pairs of legs.
12. *Ammophila ludovicus* ♂, June 1900.
13. „ *beniniensis*, ♀, Jan. 1900.
14. *Eumenes tinctor* ♂, Dec. 1899.
15. „ „ ♀, „ „
16. „ *dyschera* ♂, Feb. 1900.
17. „ „ ♀, Nov. 1899.
18. *Xylocopa hottentotta* ♀, Jan. 1900.
19. „ *carinata* ♀, Feb. 1899 to Jan. 1900.

Fig. 20. *Laparus* sp. , Jan. 1900.
21. „ ? *tabidus*, Feb. 1900.
22. *Trymodera aterrima*, Nov. 1898 to Jan. 1899.
23. *Epicauta pectoralis*, Nov. 1898 to Jan. 1899.
24. „ *subcoriacea* „ „ „ „
25. „ *cœlestina*, Feb. 1900.
26. „ „ or *subcoriacea*, Nov. 1898 to Jan. 1899.
27. *Lytta moesta*, Nov. 1898 to Jan. 1899.

The following figures represent a beautiful little group of species of *Megachile* and their mimics.

28. *Megachile nasalis* ♀, Nov. 1899.
29. „ *chrysorrhœa* ♀, Jan. 1900.
30. *Cœlioxys pusilla* ♂, Dec. 1899. Probably parasitic on one of the two former species.
31. *Laphria* sp., near *flavipes*, Feb. 1900.

## Explanation of Plate XXII.

Group of yellow-tailed, black Mashonaland Aculeates, almost entirely Diploptera, and their Mimics. A Xylocopid and its Asilid Mimic.

All the figures are about $\frac{4}{5}$ of the natural size.

All the specimens were captured by Guy A. K. Marshall, and all, except those otherwise described, are from Salisbury, Mashonaland, 5000 feet.

Fig. 1. *Scolia erythropyga* ♂, Dec. 1899.
2. „ „ ♀, April 1900.
3. *Salius tamisieri* ♂, Mar. 1900.
4. „ „ ♀, Nov. 1899.
5. „ *spectrum* ♂, Jan. 1900.
6. *Rhynchium synagroides* ♂, Feb. 1900.
7. *Synagris abyssinica*, var. ♀, Umtali, 3700 feet, Dec. 1900.
8. „ *mirabilis* ♀, April 1899.
9. „ *emarginata* ♀, Mar. 1900.
10. „ *analis* ♀, Umtali, 3700 feet, Dec. 1900.
11. „ „ ♂, Dec. 1899.
12. „ *xanthura* ♀, Jan. 1900.
13. „ *emarginata* ♂, April 1900.

Fig. 14. *Eumenes dyschera* ♂, Jan. 1900.
15. *Trochilium* sp. , Umtali, 3700 feet, Dec. 1900.
16. „ „ „ „ „
17. *Bombylius* sp. nov., Feb. 1900.
18. *Silvius pertusus*, Nov. 1898.
The two remaining figures illustrate the mimicry of a large Asilid fly for a common type of African Xylocopid bee.
19. *Xylocopa flavo-rufa* ♀, Oct. 1899.
20. *Hyperechia marshalli* ♂, Feb. 1899. Mimic of the above.

## Explanation of Plate XXIII.

### Mashonaland Aculeates and their Mimics.

All the figures are about $\frac{2}{3}$ of the natural size.

All the specimens were captured by Guy A. K. Marshall at Salisbury, Mashonaland, 5000 feet.

Figs. 1 to 11 are a group of small insects with black head and thorax and yellow or fulvous abdomen.

Fig. 1. *Elis aureola* ♀, April 1900.
2. *Philanthus fuscipennis* ♀, Feb. 1900.
3. „ *diadema* ♀, Oct. 1899.
4. „ „ ♂, Jan. 1900.
5. „ *bucephalus* ♂, Feb. 1900.
6. *Rhynchium radiale* ♀, Jan. 1899.
7. „ *rubens*, var. ♀, Jan. 1899.
8. „ „ var. ♀, Feb. 1900.
9. *Sphecodes rufiventris* ♀, April 1899.
10. *Chalcis bicolor* ♂, April 1900.
11. *Athalia bicolor*, Jan. 1900.
The two following figures represent outlying members of the group represented in Figs. 14 to 19, the colour of the head and thorax being of a darker tint.
12. *Xylocopa lateritia* ♀, Jan. 1900.
13. „ *flavo-rufa* ♀, Oct. 1899.
Figs. 14 to 19 are black, dark-winged insects with yellowish head and thorax.
14. *Podalirius acraënsis* ♀, May 1899.
15. *Anthophora basalis*? ♀, Oct. 1899.
16. *Xylocopa olivacea* ♀, June 1900.
17. „ *modesta* ♀ „ „

Fig. 18. *Elis cælebs* ♀, Dec. 16, 1900.

19. *Melittia* sp. „ „ Mimic of the above.

Figs. 20 to 29 and 31 are insects with dark-blue or blackish wings and yellow heads. Where the anterior yellow is most developed (as in Fig. 25) the group merges into the preceding one; where it is least, the convergence is towards the blue-winged group shown on Plates XX and XXI.

20. *Pompilus marshalli* ♀, Oct. 1899.

21. „ *dichrous* ♂, Jan. 1900.

22. „ „ ♀, Oct. 1899.

23. „ *lascivus* ♀, June 1900.

24. „ *anticus* ♀, Jan. 1900.

25. *Salius tamisieri* ♀, Feb. 1899.

26. *Tachysphex fluctuatus* ♀, June 1900.

27. *Bromophila caffra*, Dec. 1899.

28. *Jonthodes sculptilis*, Nov. 1898 to Jan. 1899.

29. *Eletica rufa* ♂, Nov. 1898 to Jan. 1899.

Figs. 30, 32, and 33 are blue- or black-winged insects with yellow-banded legs which are very conspicuous during flight.

30. *Litopus dispar*, Feb. 1899.

31. *Iphiaulax ruber* ♀, Oct. 1900.

32. *Osprynchotus flavipes* ♀, Jan. 1900.

33. *Pirates æneicollis*, Dec. 1900.

Figs. 34 to 36 are black insects with narrow yellow bands and clear wings.

34. *Pompilus festivus* ♀, Jan. 1899.

35. *Myzine capitata* ♂ „ „

36. *Metopius discolor* ♂ „ „

Two flies with their model a *Megachile* bee.

37. *Megachile apiformis* ♂, Jan. 1899.

38. *Eumerus* sp. nov.? „ „

39. *Laxenecera mollis*, Mar. 1900.

The following figures represent a Syrphid fly which closely mimics a common social wasp.

40. *Polistes marginalis* ♀, Dec. 1898.

41. *Ceria gambiana* „ „

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## XVIII. *New and little known species of* Drepanulidæ, Epiplemidæ, Microniidæ *and* Geometridæ *in the National Collection.* By Colonel Charles Swinhoe, M.A., F.L.S., F.Z.S., etc.

[Read April 16th, 1902.]

At the request of the authorities of the British Museum I undertook last winter, when living in London, to work out the unnamed species of the Eastern and Australian Drepanulidæ, Epiplemidæ, Microniidæ and Geometridæ in the National Collection, and this paper is the result.

At Sir George Hampson's request the Hon. Walter Rothschild kindly sent to the British Museum, for comparison, all Mr. Warren's types, and Professor Poulton was good enough to lend the Walkerian types in the Oxford University Museum.

Out of the many hundreds of Warren's types I have made notes of a few the names of which must fall; and have given lists of those not in the British Museum, to show the blanks that want filling up in the National Collection. The species not mentioned in this paper were found in the Collection and named.

The resemblance in pattern and coloration of many species, widely differing from each other structurally, is very noticeable in the Geometridæ, especially amongst the Sterrhids (Acidalids), and this family is well worth the careful study of any Biologist interested in the convergence of superficial characters. To instance a few:

*Eugnesia correspondens*, Warr., Nov. Zool., iv, p. 77, is exactly like *Syngia camptogrammaria*, Guen., but the former has simple antennæ in the male, whereas in the latter they are bi-pectinate with short stiff bristles.

*Pisoraca sordidata*, Warr., l. c., iii, p. 376; *Xenoprora parallela*, Warr., iv, p. 195, and *Perixera grisea*, Warr., vi, p. 336, are all of one pattern and colour, but differ greatly in structure.

*Brachycola paucinotata*, Warr., viii, p. 22, resembles very closely *Perixera absconditaria*, Walker, but can at once be differentiated by the structure of the legs.

*Plocucha irregularis*, Warr., iii, p. 377, is like *Anisodes pallida*, Moore, but has a costal fold in the fore-wings.

Amongst the Boarmids,

*Pseudalcis catoriata*, Warr., iv, p. 97, is almost identical with *Boarmia trispinaria*, Walker, but vein 11 of fore-wing arises out of 12 and the antennæ are plumose.

*Semiothisa fusca*, Warr., iii, p. 412, and *Xenoneura tephrinata*, Warr., p. 414, are almost exactly alike, but the former has simple antennæ in both sexes, and the male of the latter has the antennæ pectinated.

## Family DREPANULIDÆ.

Genus MIMOZETHES, Warr., Nov. Zool., viii, p. 190 (1901).

MIMOZETHES ARGENTILINEARIA.

*Deretia argentilinearia*, Leech, Ann. Mag. N. H. (6), xix, p. 183 (1897).
*Euchera* (?) *nana*, Warr., l. c., iv, p. 15 (1897).
*Mimozethes nana*, Warr., l. c., viii, p 191.

Type, Japan in B. M.
Type (*nana*), Japan in coll. Rothschild.

Genus CALLIDREPANA, Feld., Sitz. Akad. Weis. Wien, xliii, p. 30 (1861).

*Damna*, Walker, xxvi, 1570 (1862).
*Ausaris*, Walker, xxvi, 1632.
*Ticilia*, Walker, xxxii, 394 (1865).
*Drepanulides*, Motsch., Bull. Mosc., xxxix, p. 193 (1866).

CALLIDREPANA GELIDATA.

*Damna gelidata*, Walker, xxvi, 1570.
*Ticilia argentilinea*, Walker, xxxii, 394.
*Callidrepana argentifera*, Druce, P. Z. S., 1888, p. 574, pl. 29, f. 3.
*Platypteryx argentilinea*, Snellen, Tijd. v. Ent., xxxii, p. 8, pl. 1, f. 2 (1888).
*Ausaris splendens*, Warr., Nov. Zool., iv, p. 195 (1897).

Type ♀, Sarawak in O. M.
Types (*argentilinea* ♂ ♀), Singapore in O. M.
Types (*argentifera* ♂ ♀), Guadalcanar Isl. in coll. Druce.
Types (*P. argentilinea* ♂ ♀), Java in coll. Snellen.
Type (*splendens* ♀), Tawaya, north of Palos Bay, Celebes, in coll. Rothschild.

Sewa orbiferata.

*Abraxas orbiferata*, Walker, xxiv, 1126 (1862).
*Sewa orbiferata*, Swinh., Cat. Het. Mus. Oxon., ii, App. p. 591 (1900).
*Argyris insignata*, Moore, P. Z. S., 1867, p. 645.
*Platypteryx cilicoides*, Snellen, Tijd. v. Ent., xxxii, p. 9, pl. 1, f. 3 (1888).

Type, Sarawak in O. M.
Type (*insignata*), Bengal in coll. Russell.*
Type (*cilicoides*), Java in coll. Snellen.
It is also from W. China and from Bhutan in the B. M.

Teldenia vestigiata.

*Corycia vestigiata*, Butl., Ann. Mag. N. H. (5), vi, p. 222 (1880).
*Teldenia alba*, Moore, Lep. Ceylon, ii, p. 120, pl. 124, f. 1, 1a (1882).
*Teldenia fulvilunata*, Warr., Nov. Zool., iv, p. 18 (1897).

Type, Darjiling in B. M.
Type (*alba*), Ceylon in B. M.
Type (*fulvilunata* ♂), Celebes in coll. Rothschild.
*Fulvilunata* is a very well marked example.

Genus Zusidava, Walker, xxvi, 1637 (1862).

*Emodesa*, Moore, Descr. Ind. Lep. Atk., p. 255 (1888).
*Pseudemodesa*, Warr., Nov. Zool., vi, p. 314 (1899).

Zusidava tortricaria.

*Zusidava tortricaria*, Walker, xxvi, 1637.
„ „ Swinh., Cat. Het. Mus. Oxon., ii, p. 591 (1900).
*Emodesa sinuosa*, Moore, l. c., p. 256, pl. 8, f. 18.
„ „ Hmpsn., Moths, Ind., iv, App., p. 475 (1896).
*Pseudemodesa fuscidisca*, Warr., Nov. Zool., viii, p. 191 (1901).

Type, Sarawak, Borneo, in O. M.
Type (*sinuosa*), Khasia Hills in coll. Staudinger.
Type (*fuscidisca*), Mysol in coll. Rothschild.

* This collection appears to be lost.

Problepsidis excisa.

*Drepana excisa*, Hmpsn., Moths, India, i, p. 338 (1892).
*Problepsidis carneotincta*, Warr., Nov. Zool., viii, p. 191 (1901).

Type, Naga Hills in coll. Elwes.
Type (*carneotincta* ♂), Sarawak in coll. Rothschild.

I have it also from the Khasia Hills.

Tridrepana quadripunctata.

*Drepana quadripunctata*, Walker, Journ. Linn. Soc., vi, p. 175 (1862).
,, ,, Swinh., Cat. Het. Mus. Oxon., i, p. 241 (1892).
*Tridrepana diluta*, Warr., Nov. Zool., iv, p. 18 (1897).
*Tridrepana subobliqua*, Warr., l. c.

Type, Sarawak in O. M.
Type (*diluta*), Khasia Hills in coll. Rothschild.
Type (*subobliqua*), Java in ditto.

There are in the B. M. examples from the Khasia Hills, Sikkim, Singapore, and Borneo.

Tridrepana fulvata.

*Drepana fulvata*, Snellen, Tijd. v. Ent., xix, p. 19, pl. 2, f. 10 (1876).
*Drepana albonotata*, Moore, Lep. Atk., p. 83 (1879).
,, ,, Hmpsn., Moths, i, p. 340 (1892).
*Callidrepana ochrea*, Butl., Ill. Het., vi, p. 17, pl. 105, f. 10 (1886).
*Callidrepana lunulata*, Butl., Ann. Mag. N. H. (5), xix, p. 224 (1887).

Type, Java in coll. Snellen.
Type (*albonotata* ♂), Mount Parisnath, Behar, in coll. Staudinger.
Type (*ochrea* ♂), Darjiling in B. M.
Type (*lunulata* ♀), Alu, Solomon Isls., in B. M.

Cobanilla berenica.

*Drepana berenica*, Swinh., Ann. Mag. N. H. (6), xii, p. 258 (1893).

*Cobanilla hepaticata*, Warr., Nov. Zool., iv, p. 13 (1897).
*Cobanilla cardinalis*, Warr., l. c.

Type, Singapore in B. M.
Types (*hepaticata* and *cardinalis*), Penangah in coll. Rothschild.

*Cardinalis* is merely a reddish form of this species; it also occurs in Singapore.

DRAPETODES MIMULARIA.

*Drapetodes mimularia*, Snellen, Tijd. v. Ent., xxxiii, p. 11, pl. 1, f. 4, 4a (1888).
*Drapetodes lunulata*, Warr., Nov. Zool., iii, p. 336 (1896).

Type, Java in coll. Snellen.
Type (*lunulata* ♀), Java in coll. Rothschild.

DRAPETODES MAGNIFICA, nov.

♀. Ochreous brown, thorax banded with pale ochreous, also first two segments of abdomen; both wings banded and marked with pale ochreous, in the fore-wings there is a streak near the base and another at the apex as if portions of one band; there is also a broad band from the hinder margin a little beyond the middle, to the outer margin above the middle; on the hind-wings there is a sub-basal band from the abdominal margin, short, and with a white band on its inner edge, and a broad discal band which is below the apex, and at the anal angle touches the outer margin; all these bands are longitudinally streaked with bright orange lunular lines close together; there is also a brown spot at the end of each cell, a dark brown marginal line and brown cilia; on the underside the wings and body are of a uniform pale greyish-white, nearly pure white.
Expanse of wings $1\frac{5}{8}$ inches.

*Hab.* SINGAPORE.

DRAPETODES OBLIQUIFASCIATA, nov.

♂. Head, thorax, and abdomen white and ochreous; wings white with pinkish ochreous broad stripes, that on costa edged inwardly, the other two edged on both sides with chestnut-red lines; the first band is along the costa of fore-wings, the second from the abdominal margin of hind-wings close to the base, to the outer margin of fore-wings above the middle; the third runs across the centre of hind-wings, from the abdominal margin below the middle to the costa before the apex; all these stripes are parallel to each other and are

perfectly straight and even, the second stripe has two white spots at its extremity on the outer margin of the wing and a more or less distinguishable white band running inside it ; the third stripe has a more distinct white band which is dentate and edged on its lower side with brown ; outer margin of both wings with a band coloured like the stripes edged inwardly with a crenelate chestnut-red band.

Expanse of wings $1_{\frac{1}{10}}$ inches.

*Hab.* Pulo Laut (*Doherty*).

Streptopteras crenelata, nov.

♂. Differs from *S. luteata*, Hampsn.,* in the fore-wing having no white mark at apex ; hind-wing with the outer margin strongly crenelate and produced to a point at vein 6, and to two points close together at the production of the wing below the middle of the margin ; the double postmedial line with yellow spots on its outer edge, especially towards abdominal margin, the outer area rufous without the numerous crenelate lines, the submarginal dentate line with dark marks on it throughout.

Expanse of wings $1_{\frac{2}{10}}$ inches.

*Hab.* Pulo Laut (*Doherty*).

Genus Ectothyris, nov.

Palpi upturned cylindrical, the 2nd joint reaching vertex of head, the 3rd obtuse, proboscis present, antennæ laminate ; mid tibiæ with one pair of spurs, hind tibiæ with two pairs, the inner medial short ; fore-wing with the costa slightly excised beyond middle, the apex rounded, the outer margin slightly excised towards hinder angle, veins 4 and 5 from angle of cell, 6 from middle of areole, which is formed by 10 strongly anastomosing with 8 and 9 ; 11 from end of areole ; hind-wing with the frenulum present, the outer margin strongly crenelate and produced to longer points at veins 3, 4, and 6.

Ectothyris trifenestrata, nov.

♂ ♀. Ochreous suffused with rufous, anal tuft grey, fore-wing with double rufous antemedial line angled below costa, and with traces of two lines beyond it ; costal area streaked with ochreous, two dark postmedial costal marks, three hyaline patches beyond lower angle of cell, with dark speck on the veins between them, and bounded by an oblique ochreous postmedial line ; an indistinct minutely dentate ochreous submarginal line ; hind-wing with oblique dark ante-

* Trans. Ent. Soc. 1895, p. 289.

medial line, three hyaline patches beyond lower angle of cell, a dark-edged ochreous postmedial line, a dentate ochreous submarginal line; the female greyer than the male in coloration.

Expanse of wings 1 inch.

*Hab.* Pulo Laut (*Doherty*).

Gogana placida, nov.

♀. Of a uniform pinkish-grey, frons brown, pectus white, both wings with very indistinct, outwardly-curved, crenelated grey lines, ante and postmedial; fore-wings with two black dots at the end of the cell; hind-wings with three; underside paler, shining, dots as above.

Expanse of wings $1\frac{1}{10}$ inches.

*Hab.* Sandakan, Borneo (*W. B. Pryer*).

Genus Trotothyris, Warr., Nov. Zool., iv, p. 19 (1897).
Ametroptila, Warr., l. c., viii, p. 190 (1901).

Trotothyris fragilis, nov.

♂. Dark shining grey, head whitish between the antennæ; very uniform in colour, there is a red-brown streak at the end of cell of fore-wings, and some very minute silvery speckles along the costa, in the cell and interspace below the sub-costal vein, and along the outer margin; these speckles can only be seen in certain lights, when they are conspicuous, the marginal borders of both wings are dark and the cilia shining yellow; on the underside the wings are paler, the mark at the end of the cell is yellowish-white, the sex mark on fore-wings is surrounded with yellowish-white, and the body and legs are of the same colour.

Expanse of wings $\frac{8}{10}$ inch.

*Hab.* Pulo Laut, Borneo (*Doherty*).

Oreta loochooana, nov.

♂. Antennæ laminate as in *O. calceolaria*, Butl., from Japan, but the outer margin of fore-wings is evenly rounded below the incurve under the apex and is not produced in the middle as in that species, the colour is somewhat similar but duller; antennæ ochreous grey, head, body, and fore-wings dull red-brown strongly tinged with ochreous; frons, head, body below and legs bright crimson, thorax in front greyish-white, fore-wings with yellow suffusion on the basal and outer portions, beyond the double line with yellow centre, which runs straight from hinder margin beyond the middle to the apex, a blackish mark on middle of costa, one at one-fourth from apex,

another near apex, and two on hinder margin close to the angle: hind-wings yellow, the basal half red-brown strongly tinged with yellow, and a patch of that colour at the apex; some brown points in the disc; underside yellow, the red-brown portions replaced by crimson, and a black discal band on fore-wings, which is continued half-way down the middle of the hind-wings.

Expanse of wings 1½ inches.

*Hab.* Loochoo (*H. Pryer*).

Oreta rubromarginata, nov.

♀. Frons crimson, thorax and fore-wings yellow, outer margin somewhat produced at vein 4; a broad marginal chestnut-red band; hind-wings yellow in the interior part, the chestnut-red marginal band very deep, occupying nearly one-third of the wings, and there is a large chestnut-red patch with four or five angulated productions in the middle of the wing; abdomen chestnut-red, tip yellowish; underside bright yellow, the band on fore-wings pinkish in the upper half, blackish in the lower half; hind-wings with some black specks in the disc, no band; body and legs ochreous, fore-legs streaked with crimson.

Expanse of wings 1½ inches.

*Hab.* Borneo.

Phalacra tenera, nov.

♀. Ochreous grey; uniform in coloration, abdomen with grey segmental lines, wings crossed by many sinuous and more or less crenelated grey lines, two in the middle the most prominent, fore-wings with a black mark on the costa before the apex, and a black line on the apical margin, which is continued along the outer margin, there is a blackish streak on hinder margin before the angle, many grey specks and points in both wings, and some prominent lines near outer margin of hind-wings which darken the outer half of the wing and contain a submarginal whitish band; underside grey with a brown discal band across both wings.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* Pulo Laut, Borneo (*Doherty*).

Phalacra kerara, nov.

♀. With the ground colour of a uniform ochreous grey, body darker grey, wings with a minute blackish dot at the end of each cell, fore-wings with a rather broad brownish median band, a discal line of blackish lunules; the space to the outer margin brownish,

containing a pale sinuous submarginal line, hind-wings with the discal line of blackish lunules faintly indicated, and the space beyond brown with submarginal pale sinuous line as in fore-wings; underside dull ochreous grey, with a darker grey, thin discal band across both wings.

Expanse of wings $1\frac{3}{16}$ inches.

*Hab.* Pulo Laut, Borneo (*Doherty*).

The fore-wing is somewhat deeply excavated at the hinder angle, the hind-wing has the centre of the outer border produced, with an excavation below the production.

Not in B. M.

| | |
|---|---|
| *Euchera absentimacula*, Warr., Nov. Zool., iii, p. 337 . . . . . | Java. |
| *Teldenia nigrinotata*, Warr., l. c., p. 273 . | Fergusson Isl. |
| *Drepana fleximargo*, Warr., l. c., p. 272 . | Fergusson Isl. |
| „ *sera*, Warr., l. c. . . . . | Fergusson Isl. |
| *Tridrepana argentistriga*, Warr., l. c., p. 339 | N. Borneo. |
| *Drapetodes interlineata*, Warr., l. c., p. 336 | Java. |
| *Oreta fuscimargo*, Warr., l. c., p. 338 . | Queensland. |
| „ (?) *scintillans*, Warr., l. c., p. 273 . | Fergusson Isl. |
| *Cobanilla fulvata*, Warr., l. c., v, p. 423 . | Key Isl. |
| „ *jaspidea*, Warr., l. c., iii, p. 335 . | Cedar Bay. |
| *Cyclura excisa*, Warr., l. c., iv, p. 14 . | Penangah, N.E. Borneo. |

## Family EPIPLEMIDÆ.

### Paradecetia vicina, nov.

♂ ♀. Of a pale creamy mouse colour, with a violaceous tinge, very uniform in the five males and two females under examination; a white dot at end of cell, a crimson line quite straight from before middle of abdominal margin of hind-wings to apex of fore-wings as in *P. albistellaria*, Walker, from India, four red dots on disc of hind-wing in place of the white spots of that species and red cilia to both wings; underside yellowish.

Expanse of wings $1\frac{1}{2}$ inches.

*Hab.* Ta-tsien-Lu; Chang Yang; West China.

### Paradecetia myra, nov.

♂ ♀. Ochreous brown, wings thickly irrorated with very minute brown atoms, a white dot at the end of each cell, a brown straight line from before middle of abdominal margin to apex as in the preceding species; on the hind-wings the space from the line to the

outer margin dark brown, with four white dots in the disc, as in *P. albistellaria*: underside pale ochreous with brown striations.

Expanse of wings 1½ inches.

*Hab.* Moupin and Omeishan, West China.

The markings in these two forms are very similar to those in *P. albistellaria*, Walker; the latter is a very common species in the Khasia Hills, and I have a long series in my own collection. They are wonderfully uniform in colour and correspond exactly with the type, and with an example from Nepal in this museum, and the three forms seem to me to be quite distinct from each other.

Decetia dichromata.

*Decetia dichromata*, Walker, xx, 232 (1860).
„ „ Swinh., Cat. Het. Mus. Oxon., ii, p. 218, pl. 5, f. 1 (1900).
*Decetia insignis*, Butl., Ann. Mag. N. H. (5), xx, p. 242 (1887).

Type, Mysol in O. M.
Type (*insignis*), Alu in B. M.

Epiplema conflictaria.

*Erosia conflictaria*, Walker, xxiii, 851 (1861).
*Erosia exprimataria*, Walker, xxiii, 851.
*Erosia diffinaria*, Walker, xxiii, 852.
*Erosia scutaria*, Walker, xxxv, 1648 (1866).
*Erosia plicata*, Snellen, Tijd. v. Ent., xx, p. 44, pl. 3, f. 23 (1876).
*Dirades parvula*, Moore, Lep. Ceylon, iii, p. 402, pl. 186, f. 5 (1887).
*Dirades lilacina*, Moore, l. c., f. 4.
*Epiplema lacteata*, Warr., Nov. Zool., iii, p. 272 (1896).
*Epiplema perpolita*, Warr., l. c., p. 349.

Type ♂, Ceram in B. M.
Type ♀, Sarawak, Borneo, in O. M., as also are the types (*exprimataria* and *diffinaria*).
Type (*scutaria*), Sumatra in O. M.
Type (*plicata*), Java in coll. Snellen.
Types (*parvula* and *lilacina*), Ceylon in B. M.
Type (*lacteata* ♀), Fergusson Isl. in coll. Rothschild.
Type (*perpolita* ♂), Banda in ditto.

EPILEMA CARMONA, nov.

♀. Brown tinged with pink; fore-wings with an inner somewhat sinuous outwardly curved thin dark brown band, a postmedian nearly upright similar band, with a small inward angle near the hinder margin; a marginal similar band and grey cilia; hind-wings with an indistinct inner band acutely angled outwardly in its middle, a discal similar band with a pale outer edge, marginal band and cilia as on fore-wings.

Fore-wings with a double excavation between apex and centre of outer margin; hind-wings with two tails as in the common Asiatic species *E. moza*, Butler.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* KAPAUR, N. Guinea (*Doherty*).

EPIPLEMA CRETOSA, nov.

♂ ♀. Palpi brown, last two joints with white tips, head and frons white, wings chalky white, markings red, a line between the eyes in front of the base of the antennæ, some red marks behind the white collar, fore-wings speckled with red, and with two spots, ante and post-medial, some striations over most of the wing, chiefly on the upper portions, a subapical band of four dots, very faintly indicated on some specimens; hind-wings with some faint red markings on outer margin and some pale red striations inside the wings, and a small dark red streak near base of upper tail; underside white, fore-wings with the upper two-thirds suffused with brown.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* FIJI, four examples.

Belongs to the *nivosaria* group.

EPIPLEMA LABECULA, nov.

♂. Antennæ bi-pectinated for two-thirds its length; fore-wings somewhat excavated from apex to centre of outer margin, and the hind-wings excavated at anal angle and not tailed; general coloration a uniform pinkish-grey, irrorated with minute brown atoms, some of which are thickened on the fore-wings to an indistinct patch towards base, a small one on the upper disc and another small one on the costa above it; hind-wings with the outer half brownish, caused by the density of the irrorations, a brown discal outwardly rounded thin band, costa of fore-wings marked with brown, cilia of both wings dark brown.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* PULO LAUT (*Doherty*).

Epiplema suffusca, nov.

♀. Antennæ pale ochreous-grey, frons black, with a pale spot in the centre, body and both wings of uniform dull brown colour, there is a faint trace of a discal darker brown band on the hind-wings, and a black inner margin to the pale pinkish outer marginal line; on the underside the colour is paler, and all the margins pale pinkish, legs nearly white.

Expanse of wings $\frac{3}{4}$ inch.

*Hab.* Fergusson Isl. (*Meek*).

The outer margin of fore-wings is somewhat incurved between apex and centre, and the hind-wings have two very short tails.

Epiplema amœna, nov.

♀. White with chocolate-brown markings, fore-wings with the costa mottled, a mark like two short lines at end of cell, a discal duplex outwardly curved band, a spot on costa before apex, one in middle of outer margin and one at hinder angle; three little spots on margin from apex to the centre spot; hind-wings with a spot at end of cell; a duplex discal band apparently acutely angled outwardly below, but the lower part of the band is obscured by some blackish suffusion near anal angle connecting two black spots, one above the angle and the other on base of lower tail; underside pure white.

Expanse of wings $\frac{3}{4}$ inch.

*Hab.* Kapaur, N. Guinea (*Doherty*).

Belongs to the *E. conflictaria*, Walker, group.

Epiplema fucina, nov.

♂. Outer margin rounded, hind-wings with two tails; of a uniform purplish-brown, tinged with pink, fore-wings with the costa mottled with pink and with brown, inner band obsolescent; outer band blackish with pale pinkish outer edging; curving outwards from costa at one-third from apex to the middle of the disc, and again from hinder margin near the angle for a short distance erect, these two parts of this band are apparently joined together, but by so indistinct a line as to be hardly visible; a pale pinkish line outwardly edged with black close to the outer margin; hind-wings with a largish black spot at end of cell, a discal outwardly curved, somewhat sinuous white line edged inwardly with black, a marginal

black line, ochreous cilia, and a black spot at base of the lower tail, this spot is crossed by a white mark ; underside fore-wing grey, hind-wings pure white without markings.

Expanse of wings $\frac{8}{16}$ inch.

*Hab.* Pulo Laut (*Doherty*).

Genus Chundana, Walker, Journ. Linn. Soc., vi, p. 116 (1862).
Paradirades, Warr., Nov. Zool., iii, p. 353 (1896).

Chundana lugubris.

*Chundana lugubris*, Walker, l. c., p. 117.
„ „ Swinh., Cat. Het. Mus. Oxon., i, p. 105, pl. 3, f. 20 (1892).
*Paradirades farinosa*, Warr., l. c., vi, p. 12 (1899).

Type, Sarawak in O. M.
Types (*farinosa* ♂ ♀), St. Aignan in coll. Rothschild.

Chundana assimilis.

*Paradirades assimilis*, Warr., Nov. Zool., iii, p. 353 (1896).
*Paradirades maculata*, Warr., l. c., iv, p. 205 (1897).

Type ♂, Cedar Bay in coll. Rothschild.
Type (*maculata* ♂), Bali in ditto.

Warren also reports *assimilis* as from Humboldt Bay.

Genus Chætoceras, Warr., Nov. Zool., iii, p. 344 (1896).

*Chætoceras simplex*, Warr., l. c.
*Eversmannia diversipennis*, Warr., l. c., p. 350.

Types, Amboina in coll. Rothschild.

The type of *simplex* is a male, of *diversipennis* there are both sexes, all collected by Doherty in Amboina in February 1892; the species is not represented in the B. M. collection.

Dirades mutans.

*Erosia mutans*, Butl., Ann. Mag. N. H. (5), xix, p. 434 (1887).
*Dirades leucocera*, Hmpsn., Ill. Hett., viii, p. 102, pl. 150, f. 13 (1891).
*Dirades annulifer*, Warr., Nov. Zool., iii, p. 274 (1896).

*Dirades seminigra*, Warr., l. c., p. 203 (1897).
*Epiplema rhombifera*, Warr., l. c., iv, p. 203 (1897).

Type, Alu in B. M.
Type (*leucocera*), Nilgiri Hills in B. M.
Type (*annulifer* ♂), Kiriwini, Trobriand Isl., in coll. Rothschild.
Type (*seminigra* ♀), Cedar Bay in ditto.
Type (*rhombifera* ♀), Oinainisa, Dutch Timor, in ditto.

GATHYNIA CESENA, nov.

♂. Purplish-brown tinged with pink; fore-wings with the upper part darkest, with a discal blackish line outwardly edged with white, curving outwards slightly, and with a slight indentation in its middle; hind-wings with a large white costal patch and a discal line similar to that on the fore-wings, the white patch with its lower edge evenly curved except where the line runs through it, where it is slightly toothed down the line; black dots on outer margin of both wings; underside fore-wings paler, hind-wings white, no markings.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* PULO LAUT (*Doherty*).

GATHYNIA CYTHERA, nov.

♂. Frons chocolate-brown, top of head white, thorax purple-brown, abdomen pinkish-grey, basal portion brownish; fore-wings pale pinkish-greyish-brown, thickly irrorated with very minute blackish-brown atoms, the central half of the wing darkest; indications of two transverse brown bands rather close together ante and post-medial; pale pinkish dots on outer margin; hind-wings with a large white costal patch, straight cut at its outer end, the lower part of it with a white streak to the outer margin, the upper two-thirds of the rest of the wings is blackish, the abdominal region whitish tinged with pink; underside fore-wings pale pinkish-grey; hind-wings white.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* FIJI, five male examples.

Not in B. M.

*Epiplema denigrata*, Warr., Nov. Zool., iii, p. 276 . . . . . Kiriwini.
„ *grisea*, Warr., l. c. . . . . Kiriwini.
„ *particolor*, Warr., l. c., p. 277 . . Fergusson Isl.
„ *sordida*, Warr., l. c., p. 278 . . Fergusson Isl.

*Epiplema undulata*, Warr., l. c. . . . . Fergusson Isl.
„ *ambusta*, Warr., l. c., p. 347 . . . Banda.
„ *curvilinea*, Warr., l. c., p. 348. . . Amboina.
„ *nana*, Warr., l. c. . . . . Tenimber Isl.
„ *oculifera*, Warr., l. c., p. 349 . . . Dili Timor.
„ *inangulata*, Warr., l. c., p. 350 . . Batchian.
„ *cæsia*, Warr., l. c., iv, p. 252 . . . Manilla.
„ *nivipuncta*, Warr., l. c. . . . . Manilla.
„ **paradeicta*, Warr., l. c., p. 26 . . S. Celebes.
„ *amygdalipennis*, Warr., l. c., p. 201 . . Apia Upola.
„ *discata*, Warr., l. c., p. 202 . . . S. Celebes.
„ *lugens*, Warr., l. c. . . . . Apia Upola.
„ *nictitans*, Warr., l. c., p. 203 . . . Padang Rengas.
*Chætopyga horrida*, Warr., l. c., iii, p. 345 . . Mackay.
*Dysrhombia longipennis*, Warr., l. c., p. 347 . . Cedar Bay.
*Dirades exangulata*, Warr., l. c., iv, p. 200 . . N. Borneo.
„ *pygmeata*, Warr., l. c., p. 201 . . . Lombok.
„ *acutilinea*, Warr., l. c., p. 384 . . . Penang.
„ *latibrunnea*, Warr., l. c., iii, p. 345 . . Lifu.
*Diradopsis perfallax*, Warr., l. c., v, p. 425 . . Key Isl.
*Paradirades fulvilunata*, Warr., l. c., p. 230 . . Kapaur.
*Platerosia rotundipennis*, Warr., l. c., p. 280 . . Fergusson Isl.
*Monobolodes subfalcata*, Warr., l. c., v, p. 230 . Dawson.
*Lobogethes interrupta*, Warr., l. c., iii, p. 352 . . N. Queensland.
*Macrostylodes deformis*, Warr., l. c. . . . Humboldt Bay.
*Gathynia vinosa*, Warr., l. c., p. 351 . . . Dili Timor.
„ *divaricata*, Warr., l. c., iv, p. 26 . . Bonthain.
„ *lignata*, Warr., l. c., p. 204 . . . Bali.
„ *despecta*, Warr., l. c., v, p. 229 . . . Dawson.

## Family MICRONIIDÆ.

### Urapteroides anerces.

*Strophidia anerces*, Meyrick, Trans. Ent. Soc., 1886, p. 201.
*Micronia nemœa*, Druce, P. Z. S., 1888, p. 227, pl. 13, fig. 9.

Type, Fiji in coll. Meyrick.
Type (*nemœa*), Fiji in coll. Druce.

### Urapteroides latimarginata.

♂. Pure white, top of head brown, fore-wings with a broad costal pale brown band, thickly marked with dark brown striations,

* *Epiplema paucinotata* on type label, name subsequently altered, but the type label has not been altered.

both wings with outer marginal similarly coloured bands, not striated, the band is broad above, broader than the costal band, slightly narrowing hindward, the usual two black spots at the tail where the margin is white: underside same as upperside, but all the bands paler and without striations, fore-legs brown in front.

Expanse of wings $2\frac{5}{10}$ inches.

*Hab.* Kaiser Wilhelm's Land.

Differs from *U. caudiferaria*, Boisd. = *mundata*, Walker, in having the band on the hind-wing marginal and not submarginal.

Stesichora basiguttaria.

*Micronia basiguttaria*, Walker, xxxv, 1641 (1866).
*Stesichora basiguttaria*, Swinh., Cat. Het. Mus. Oxon., ii, p. 224 (1900).
*Stesichora inquinata*, Warr., Nov. Zool., viii, p. 192 (1901).

Type, Mysol in O. M.
Type (*inquinata*), Mysol in coll. Rothschild.

Stesichora pieridaria.

*Micronia pieridaria*, Guen., Phal., ii, 30, 940 (1857).
*Stesichora pieridaria*, Warr., Nov. Zool., iv, p. 24 (1897).
*Stesichora quadristrigata*, Warr., l. c., iii, p. 274 (1896).
*Micronia notabilis*, Pag., Abh. Ges. Zool., p. 127, pl. 2, fig. 33 (1900).

Guenée's type had no locality.

Type (*quadristrigata* ♀), Fergusson Isl. in coll. Rothschild.
Type (*notabilis*), N. Guinea in coll. Pagenstecher.

Stesichora puellaria.

*Micronia puellaria*, Walker, xxxv, 1641 (1866).
*Micronia titania*, Kirsch., Mitth. Dresd., p. 134, pl. 7, fig. 11 (1877).
*Stesichora sphæristis*, Meyrick, Proc. Linn. Soc., N.S.W., 1886, p. 247.
*Stesichora nivea*, Warr., Nov. Zool., iv, p. 24 (1894).
*Stesichora obsolescens*, Warr., l. c., p. 384.
*Stesichora unipuncta*, Warr., l. c., vi, p. 9 (1899).
*Stesichora multiguttata*, Warr., l. c., viii, p. 21 (1901).

Type, N. Guinea in O. M.
Type (*titania*), N. Guinea in Mus. Dresden.
Type (*sphæristis*), Fly River, N. Guinea, in Melbourne Mus.
Type (*nivea*), Ke' Isl. in coll. Rothschild.
Type (*obsolescens* ♂ ♀), from Woodlark Isl. and Egum Isl. in ditto.
Type (*unipuncta*), Goodenough Isl. in ditto.
Type (*multiguttata*), Aru in ditto.

The number of spots on the margin is the character on which these types are based, but it is not a specific character, hardly any two specimens having the same number.

## Family BOARMIIDÆ.

### Subfamily *OURAPTERYGINÆ.*

OURAPTERYX CRETEA, nov.

♀. Of a chalky white colour; fore-wings with a creamy grey streak across end of cell, and internal and external transverse thick lines of the same colour, much as in *subpunctaria*, Leech, and *similaria*, Leech: hind-wings with a short medial transverse creamy grey line as in *similaria*, two spots one above and the other below the base of the tail, the upper one pink, inwardly ringed with black, the lower one a black dot: both wings with ochreous grey cilia and submarginal fascia formed of pale grey striations; on the hind-wings this fascia is further away from the margin than it is in *similaria*.

Expanse of wings $1\frac{7}{10}$ inches.

*Hab.* OJIGOKU, Japan, four examples, all females.

THINOPTERYX DELECTANS.

*Thinopteryx delectans*, Butler, Ill. Het., ii, p. 45, pl. 35, fig. 2 (1878).
*Thinopteryx marginata*, Warr., Nov. Zool., vi, p. 43 (1899).

Type, Yokohama in B. M.
Type (*marginata* ♂), China in coll. Rothschild.

The type of *marginata* is smaller than *delectans*. The size seems to vary much, but otherwise the two forms are identical.

Not in B. M.

*Ourapteryx incaudata*, Warr., Nov. Zool., iv, p. 75 . Kina Balu.
„ *modesta*, Warr., l. c., p. 127 . . . Java.
*Urapteryx fulvinerris*, Warr., l. c., i, p. 399 . . Padang.

Subfamily *PLUTODINÆ*.

BAPTA PURA, nov.

♀. Palpi chestnut-red, frons ochreous, head, body and all the wings pure white, without any visible markings; in some lights there is a shadowy mark at the end of the cell of the fore-wings, and inner and outer transverse lines, and a central line in hind-wings, but these markings are very shadowy and not to be depended on.

Expanse of wings $1\frac{7}{10}$ inches.

*Hab.* SUMATRA.

The outer margins of both wings are rounded as in *B. brunneiceps*, Warren.

BAPTA ALBIPUNCTA, nov.

♂. Fore-wings white sprinkled with grey scales, a dark grey cell spot and traces of an inner line on inner margin; an oblique diffuse somewhat dentate line of grey scales from below apex to two-thirds of inner margin, and a broad submarginal band of grey scales: apex with a velvety black dash, costa ochraceous; extreme outer margin clear white, fringe silvery grey, with the base yellowish, and a fine orange line round apex; hind-wings with curved postmedian grey line: face and palpi brown; vertex, thorax and abdomen white.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* HAIPAW, Burma (*de Nicéville*).

Allied to *B. nigripunctaria*, Leech, from China, the only other Bapta which has a black spot at apex of fore-wing.

BAPTA MYTYLATA.

*Corycia mytilata*, Guen., Phal., ii, 58, 991 (1857).
*Cabera margarita*, Moore, P. Z. S., 1867, p. 647.
*Corycia alba*, Moore, Lep. Atk., p. 261 (1888).
*Bapta griseola*, Warr., P. Z. S., 1893, p. 386.
*Bapta distans*, Warr., Nov. Zool., i, p. 404 (1894).

Guenée's type came from N. India.

Types (*margarita* and *alba*), Bengal and Darjiling in coll. Staudinger.

Type (*griseola*), Darjiling in coll. Elwes.

Type (*distans* ♀), Japan in coll. Rothschild.

*Distans* is in the B. M. from Omeishan and other places in Central and Western China, and also from Japan, and I cannot see what there is to distinguish it from the Indian form.

BAPTA TRISERIATA, nov.

♀. Silvery white, wings sparsely irrorated with very minute brown atoms; a black dot at the end of each cell; both wings with discal and submarginal parallel grey bands more or less dentated, and grey cilia; fore-wings with a central band from the cell dot to the hinder margin: underside pure white, no markings, cilia grey.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* ALU, Solomon Islands.

This is an MS. name of Mr. Warren's, but I cannot find any reference.

DEILINIA PUNCTATA.

*Deilinia* (?) *punctata*, Warr., Nov. Zool., i, p. 405 (1894).
*Bapta candidaria*, Leech, Ann. Mag. N. H. (6), xix, p. 198 (1897).

Type ♀, Japan in coll. Rothschild.
Type (*candidaria*), Oiwake, Japan, in B. M.

AUZEODES CHALYBEATA.

*Decetia chalybeata*, Walker, xxxv, 1558 (1866).
*Auzeodes nigroseriata*, Warr., P. Z. S., 1893, p. 405.
„ „ Hmpsn., Moths, India, iii, p. 151 (1895).
„ „ Warr., Nov. Zool., iv, p. 255 (1897).
*Auzeodes uniformis*, Warr., l. c., viii, p. 200 (1901).

Type, Sumatra in O. M.
Type (*nigroseriata* ♂), E. Pegu in coll. Elwes.
Type (*nigroseriata* ♀), Selangore in coll. Rothschild.
Type (*uniformis* ♀), Sarawak in ditto.

I have seen a good many: there are hardly two alike.

APLOCHLORA VIVILACA.

*Iodis vivilaca*, Walker, xxii, 544 (1861).
*Aplochlora subflava*, Warr., Nov. Zool., iii, p. 392 (1896).

Type, Ceylon in B. M.
Type (*subflava* ♀), Humboldt Bay in coll. Rothschild.

*Subflava* is faded in colour, and though thus differing from fresh examples, it very closely resembles Walker's old type specimen, which is also much faded; it is in the B. M. from Burma, Bombay, Ceylon and Bali.

MICRONISSA TRISTIS, nov.

♂. Of a uniform dull pale ochreous, fore-wings with apparently seven and hind-wings with five indistinct slightly darker ochreous, very sinuous and irregular transverse thin bands; antennæ serrate, hind-wings rounded.

Expanse of wings $1\frac{1}{10}$ inches.

*Hab.* TALAUT (*Doherty*).

PLUTODES SIGNIFERA.

*Plutodes signifera*, Warr., Nov. Zool., iii, p. 296 (1896).

Types ♂♀, Fergusson Isl. in coll. Rothschild.

The sexes in this genus as a rule do not differ, but the sexes in Warren's *signifera* are very unlike each other, and I do not believe they belong to one and the same species. This is not in the B. M.

PERATOPHYGA FLAVOMACULATA, nov.

♀. Fore-wings with the basal patch brown, its outer edge projecting outwards in the middle, containing at base of costa two confluent rounded yellowish spots, followed by a third; marginal third purplish-brown, its inner edge projecting inwards at the middle and again squarely on submedian fold; submarginal line waved, pale, very faint; central fascia between the dark basal and marginal areas pale yellow flushed with deeper yellow, containing a curved row of dark spots on the veins, and with both edges lustrous white; a fine dark marginal line, interrupted by orange dots at the vein ends; cilia purplish, darker on basal half, which is chequered opposite the veins with yellow. Hind-wings similar, but basal patch without yellow spots. Underside with the brown darker and the yellow paler and purer. Vertex, collar, shoulders, and second segment of abdomen yellow; face, patagia, thorax and rest of abdomen brown; antennæ annulated dark and light.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* PULO LAUT one example, BORNEO one example.

About half the size of *P. trigonata*, Walker.

LOMOGRAPHA HYRIARIA, nov.

*Heterostegane hyriaria*, Warr., Nov. Zool., i, p. 406 (1894).
*Stegania irroraria*, Leech, Ann. Mag. N. H. (6), xix, p. 203 (1897).

Type, Japan in coll. Rothschild.
Type (*irroraria*), Kiushiu, Corea, in B. M.

There are also examples from N.E. China.

LOMOGRAPHA TENEBROSA, nov.

♀. Dull pale ochreous grey tinged with brown, head and collar dark brown, fore-wings with the costa brown, both wings with a small brown ringlet at end of each cell, and broad pale red-brown outer marginal band, this band contains a discal dull black fine line, which is duplex on the fore-wings, and is connected with the marginal line above and below the middle, by obscure brownish bands, marginal black lunules on both wings; the underside is pale ochreous grey, with broad purplish-brown marginal bands and brown cell spots.

Expanse of wings 1 inch.

*Hab.* SINGAPORE (*H. N. Ridley*).

PARASYNEGIA PURPURASCENS.

*Parasynegia purpurascens*, Warr., Nov. Zool., i, p. 410 (1894).
*Synegia roscaria*, Leech, Ann. Mag. N. H. (6), xix, p. 204 (1897).

Type ♂, Ichang in coll. Rothschild.
Type (*roscaria*), Ichang in B. M.

PARASYNEGIA DIFFUSARIA.

*Anisodes diffusaria*, Moore, P. Z. S., 1867, p. 641.
*Anisodes punctifera*, Butler, Ann. Mag. N. H. (5), vi, p. 220 (1880).
*Parasynegia parumnotata*, Warr., Nov. Zool., vi, p. 342 (1899).

Type, Bengal in B. M.
Type (*punctifera*), Darjiling in B. M.
Type (*parumnotata* ♀), Lawas in coll. Rothschild.

I can see no specific difference.

PARASYNEGIA SUFFUSA.

*Parasynegia suffusa*, Warr., P. Z. S., 1893, p. 414.

*Synegia gopterana*, Swinh., Trans. Ent. Soc., 1894, p. 206.
*Parasynegia borbachodes*, Warr., Nov. Zool., iii, p. 393 (1896).

Type, Naga Hills in coll. Elwes.
Type (*gopterana*), Khasia Hills in B. M.
Type (*borbachodes* ♀), W. Java in coll. Rothschild.

I cannot separate these. Sir George Hampson puts them under his *erythra* from the Nilgiri Hills, but in this arrangement I do not agree.

Synegia camptogrammaria.

*Anisodes camptogrammaria*, Guen., Phal., i, 420, 691 (1857).
*Anisodes imitaria*, Walker, xxii, 643 (1861).
*Anisodes* (?) *obrimaria*, Walker, xxii, 644.
*Syntaracta æmula*, Warr., Nov. Zool., i, p. 408 (1894).
*Syntaracta obscura*, Warr., l. c.
*Syntaracta varians*, Warr., l. c., p. 409.
*Syntaracta maculosata*, Warr., l. c., iii, p. 129 (1896).

Guenée's type came from Sarawak.

Types (*imitaria* and *obrimaria*), Ceylon in B. M.
Types (*æmula* ♂ ♀), Ceylon in coll. Rothschild.
Types (*obscura* ♂ ♀), Nilgiri Hills in ditto.
Type (*varians* ♀), Gunong Ijan in ditto.
Types (*maculosata* ♂ ♀), Khasia Hills in ditto.

It is also in the B. M. from Sarawak and from several parts of India.

Synegia lineata.

*Syntaracta varians ab lineata*, Warr., Nov. Zool., i, p. 409 (1896).

Type ♀, Gunong Ijan in coll. Rothschild.

I believe this to be a good species and not an aberration: it is not in the B. M. *Syntaracta ocellata*, Warr., l. c., p. 408, is very close to some Nilgiri examples of *campto grammaria* in the B. M., but I have only been able to examine the female type.

Eugnesia sanguinata.

*Eugnesia sanguinata*, Warr., Nov. Zool., iv, p. 78 (1897).

*Eugnesia fasciata*, Warr., l. c., vi, p. 43 (1899).

Type ♂, Roon Isl., Dutch N. Guinea, in coll. Rothschild.
Type (*fasciata* ♀), St. Aignan in ditto.

I think these must be sexes of the same species.

Borbacha euchrysa.

*Onychodes euchrysa*, Lower, Tr. Roy. Soc., S. Austral., xviii, p. 82 (1894).
*Borbaca pardaria ab parviscripta*, Warr., Nov. Zool., iii, pp. 130 and 296 (1896).

Type, Queensland in coll. Lower.
Type (*parviscripta*), Java in coll. Rothschild.

A good species, and very widely spread, Java, Fergusson Isl., Trobriand Isl., and Australia.

Not in B. M.

| | |
|---|---|
| *Auzeodes rufa*, Warr., Nov. Zool., iv, p. 255 | Penang. |
| *Tasta chalybeata*, Warr., l. c., p. 76 . . | S. Celebes. |
| *Platycerota crinita*, Warr., l. c., p. 120. . | Luzon. |
| *Leucetera subfuscata*, Warr., l. c., vi, p. 342 | Bouru. |
| *Peratostega coctata*, Warr., l. c., iv, p. 80 . | Pulo Bai, N.E. Borneo. |
| *Pristostegania bilineata*, Warr., l. c., p. 81. | Borneo. |
| *Scardamia fasciata*, Warr., l. c., iii, p. 296. | Fergusson Isl. |
| *Parasynegia nigrifasciata*, Warr., l. c., p. 393 | S. Java. |
| „ *nigrifrons*, Warr., l. c., p. 239 . | Bonthain, Celebes. |
| *Heterostegane gammata*, Warr., l. c., viii, p. 197 . . . . . | Sarawak. |
| „ *semifasciata*, Warr., l. c., vii, p. 111 . . . . . | Bouru. |
| *Eugnesia intensa*, Warr., l. c., iv, p. 396 . | S. Celebes. |
| *Borbaca lineata*, Warr., l. c., iii, p. 392 . | W. Java. |
| *Yashmakia veneris*, Warr., l. c., viii, p. 197. | Sarawak. |
| *Plectoneura albida*, Warr., l. c., iii, p. 390 . | Bt. N. Guinea. |

Subfamily *ENNOMINÆ*.

Hypochrosis ocellata.

*Patruissa sternaria ab ocellata*, Warr., Nov. Zool., i, p. 448 (1894).

Type ♂, Padang in coll. Rothschild.

Appears to me to be a good species and not an aberration; not in B. M.

Hypochrosis albodecorata, nov.

♂. Head and body brown, fore-wings white, costa striated with brown and some striations near the base and along the hinder margin, a large brown costal patch beyond the middle excavated hindwards, its outer corner joined to the broad brown marginal band, leaving a white spot below the costa near apex. Hind-wings bright ochreous, abdominal border broadly brownish; underside uniformly bright ochreous, the costal spots and upper part of marginal border indicated through the wing.

Expanse of wings $1\frac{6}{10}$ inches.

*Hab.* Borneo.

Prionia semifulva.

*Eurymene semifulva*, Pag. J. B., Nass. Ver., xxxix, p. 153 (1886).

*Prionia obliquilineata*, Warr., Nov. Zool., ii, p. 153 (1895); nec P. Z. S., 1893, p. 409.

Type, N. Guinea in coll. Pagenstecher.

Type (*obliquilineata* ♀), N. Guinea in coll. Rothschild.

Prionia mediusta.

*Prionia obliquilineata ab mediusta*, Warr., Nov. Zool., v, p. 431 (1898).

Type, Key Isl. in coll. Rothschild.

Undoubtedly a good form and not an aberration.

Prionia pallida.

*Zomia pallida*, Moore, P. Z. S., 1877, p. 622.

*Zomia innotata*, Warr., Nov. Zool., iv, p. 402 (1897).

Type, Andamans in B. M.

Types (*innotata* ♂♀), Penang in coll. Rothschild.

There are also examples in the B. M. from Java and Sumbawa; they are not distinguishable from the Andaman examples.

Prionia spurca, nov.

♀. Body and wings violet-grey tinged slightly with ochreous, and densely irrorated with minute brown atoms, fore-wings with two large chestnut-brown spots on the costa medial and subapical: hind-wings with the costal third bright ochreous, a thick chestnut-brown straight line from the anal angle to vein 4, the line outwardly

margined with pale ochreous white, cilia of both wings grey; underside uniform ochreous.

Expanse of wings $1\frac{3}{5}$ inches.

*Hab.* SANDAKAN, N. E. Borneo (*W. B. Pryer*).

EURYTAPHRIA CHLOROCHROA.

*Deilinia chlorochroa*, Meyrick, Trans. Ent. Soc., 1897, p. 78.
*Eurytaphria minorata*, Warr., Nov. Zool., iv, p. 255 (1897).

Type, Pulo Laut in coll. Elwes.
Types (*minorata* ♂ ♀), Bali in coll. Rothschild.

CORYMICA SPECULARIA.

*Caprilia specularia*, Moore, P. Z. S., 1867, p. 649, pl. 33, f. 11.
*Thiopsyche pryeri*, Butler, Ann. Mag. N. H. (5), i, p. 393 (1878).
*Corymica vitrigera*, Butler, Ill. Het., vii, p. 101, pl. 135, f. 14 (1889).
*Corymica exiguinota*, Hmpsn., Ill. Het., viii, p. 114, pl. 151, f. 12 (1891).
*Corymica oblongimaculata*, Warr., Nov. Zool., iii, p. 305 (1896).

Type, Assam in B. M.
Type (*pryeri*), Yokohama in B. M.
Type (*vitrigera*), Dharmsala in B. M.
Type (*exiguinota*), Nilgiri Hills in B. M.
Type (*oblongimaculata* ♂), Fergusson Isl. in coll. Rothschild.

HYPOSIDRA PICARIA.

*Lagyra picaria*, Walker, xxxv, 1541 (1866).
*Hyposidra cæsia*, Warr., Nov. Zool., iv, p. 257 (1897).
*Hyposidra ruptifascia*, Warr., l. c., viii, p. 201 (1901).

Type, Java in B. M.
Type (*cæsia* ♂), Penang in coll. Rothschild.
Type (*ruptifascia* ♀), Borneo in ditto.

I do not see how these can be separated. All these black and white *Hyposidras* are more or less variable; it is in the O. M. from both Java and Borneo, and there is a male from Sumatra in the B. M. identical with Warren's female.

Hyposidra albifurcata.

*Hyposidra albifurcata*, Warr., Nov. Zool., iv, p. 119 (1897).
*Hyposidra lactemaculata*, Warr., l. c., v, p. 254 (1898).

Type ♂, Bongao in coll. Rothschild.
Type (*lactemaculata* ♂), Mindoro in ditto.

Apparently one and the same species; not in the B. M.

Hyposidra flaccida.

*Lagyra flaccida*, Lower, Pr. Linn. Soc. N.S.W. (2), viii (1894).
*Hyposidra schistacea*, Warr., Nov. Zool., iii, p. 305 (1896).

Type, N.S. Wales in coll. Lower.
Types (*schistacea* ♂ ♀), Fergusson Isl. in coll. Rothschild.

Probably only a form of the very variable *H. talaca*, Walker.

Hyposidra incomptaria.

*Lagyra incomptaria*, Walker, xxxv, 1539 (1866).
*Lagyra corticata*, Walker, xxxv, 1540.
*Hyposidra variabilis*, Warr., Nov. Zool., iii, p. 306 (1896).
*ab pallida*, Warr., l. c.
*ab nubilosa*, Warr., l. c.
*ab tetraspila*, Warr., l. c., p. 416.
*ab innotata*, Warr., l. c., p. 417.
*ab siccifolia*, Warr., l. c., iv, p. 119 (1897).
*ab pallidiplaga*, Warr., l. c., vi, p. 357.
*Hyposidra maculipennis*, Warr., l. c., iii, p. 416.
*Hyposidra prunicolar*, Warr., l. c., iv, p. 119.

Type ♂, Aru in O. M.
Type (*corticata* ♂), Tondano in O. M.
Types (*variabilis*, *pallida*, and *nubilosa*), Fergusson Isl.; (*tetraspila*, *innotata*, and *prunicolar*) New Guinea, (*siccifolia*) Cedar Bay, (*pallidiplaga*) South East Isl., (*maculipennis* ♀) Solomons, all in coll. Rothschild.

Hardly two specimens of this very variable species are ever alike, and consequently there might be no limit to synonyms if all aberrations are to be named.

Hyposidra ingrata.

*Hyposidra leucomela ab ingrata*, Warr, Nov. Zool., vii, p. 116 (1900).

Type ♀, Basilan in coll. Rothschild.

I believe this to be a good species and not an aberration of Walker's *leucomela;** it lacks the white basal band to the hind-wings, which is a prominent character in Walker's species, Walker's type is also a female; it is equal to Felder's *leptosoma* from Luzon, which is a male.

Petelia vexillaria.

*Pachydia vexillaria*, Guen., Phal., ii, 138, 1147 (1857).
*Pachydia capitata*, Walker, xxiii, 109 (1861).
*Alana rubiginata*, Walker, xxxv, 1568 (1866).
*Tacparia* (?) *morosa*, Butler, Trans. Ent. Soc., 1881, p. 403.
*Petelia furva*, Warr., Nov. Zool., iv, p. 398 (1897).

Guenée's type came from Borneo.
Type (*capitata* ♀), India, should be in O. M.; but is lost.
Type (*rubiginata*), India in O. M.
Type (*morosa*), Japan in B. M.
Type (*furva* ♂), Celebes in coll. Rothschild.

It is very difficult from the description to identify Guenée's *vexillaria:* Sir George Hampson identified it as *Deilinia riobearia* (Moths, iii, p. 217). I identified it as *Petelia larentiata* (Cat. Het. Mus. Oxon., ii, p. 252), but Dr. Frederick Moore had the advantage of examining Guenée's type, and there is an example of this species in the B. M. marked by Moore as same as Guenée's type of *vexillaria*.

Petelia circularia, nov.

♀. Creamy grey tinged with pink, with brown-pink markings, a band on thorax in front, the basal half brown, and the basal half of abdomen with broad segmental bands; fore-wings with two bands of square spots at the base, the one near costal margin divided into two, a thin band (almost a line) from costa beyond the middle to hinder margin, where it is indented and is close to the inner lower end of a very large ring, which extends from hinder margin at the angle to near apex and is quite round, has a broad rim of brown-pink containing a pink line; near the apex there are two brown marks joined to

* xxxv, 1877 (1866).

the ring. Hind-wings with the base brown-pink, limited by a small white sinuous streak, the brown base extending narrowly along costa, outer margin of fore-wings with brown lunules, of hind-wings with a brown line: underside pinkish-grey with broad marginal grey bands.

Expanse of wings $1\frac{2}{16}$ inches.

*Hab.* Sandakan, Borneo (Creagh coll.).

Hyperythra lutea.

*Phalæna (Geometra) lutea*, Crum., Pap. Exot., iv, pl. 370, f. c.d. (1782).
*Hyperythra simplex*, Warr., Nov. Zool., vi, p. 60 (1899).

Type (*simplex* ♂), Sula Besi in coll. Rothschild.

One of the many named forms of *lutea*.

Hyperythra rubricata.

*Hyperythra lutea rubricata*, Warr., Nov. Zool., v, p. 35 (1898).

Type ♂, Geraldton in coll. Rothschild.

I believe this to be a perfectly good form or species; it is in the B. M., from Claremont Isl., Queensland; *lutea* does not appear to occur in Australia.

Fascellina subsignata.

*Fascellina subsignata*, Warr., P. Z. S., 1893, p. 399.
*Fascellina curtaca*, Swinh., Ann. Mag. N. H. (6), xii, p. 220 (1893).
*Fascellina inconspicua*, Warr., Nov. Zool., i, p. 446 (1894).

Type, Sikhim in coll. Elwes.
Type (*curtaca*), Khasia Hills in B. M.
Type (*inconspicua* ♂), Padang in coll. Rothschild.

I have it also from Penang.

Fascellina clausaria.

*Fascellina clausaria*, Walker, xxxv, 1556 (1866).
*Monosca subnotata*, Walker, Char. Undescr. Lep. Het., p. 29 (1869).
*Fascellina deflavata*, Warr., Nov. Zool., iv, p. 256 (1897).

Type ♀, Sumatra in O. M.
Type (*subnotata* ♀), without locality in coll. Norris.
Type (*deflavata* ♂), Selangore in coll. Rothschild.

ZETHENIA CONTIGUARIA.

*Zethenia contiguaria*, Leech, Ann. Mag. N. H. (6), xix, p. 223 (1897).
*Zethenia obscura*, Warr., Nov Zool., vi, p. 66 (1899).

Type, W. China in B. M.
Types (*obscura* ♂ ♀), Formosa in coll. Rothschild.

Not in B. M.

*Capasa viridifascia*, Warr., Nov. Zool., iii, p. 415 . . . . . Humboldt Bay.
*Omiza columbaris*, Warr., l. c., p. 417 . . Java.
„ *subaurantiaca*, Warr., l. c., p. 418 . Dili.
„ *chlorophora*, Warr., l. c., iv, p. 120 . Wetter.
„ *lubricata*, Warr., l. c., vi, p. 65 . . S. Flores.
*Polyacme dentata*, Warr., l. c., iii, p. 418 . Lifu.
*Zomia purpurascens*, Warr., l. c., i, p. 450 . Engano.
*Prionia fulvifusa*, Warr., l. c., viii, p. 36 . Borneo.
„ *hæmatopis*, Warr, l. c., v, p. 255 . Bouru.
„ *rufipennis*, Warr., l. c., v, p. 255 . Sibutu.
*Casbia scardamiata*, Warr., l. c., p. 431 . . Key.
„ *anomalata*, Warr., l. c., vi, p. 353. . Woodlark Isl.
*Parametrodes aurantiacata*, Warr., l. c., p. 354 Sud Est Isl.
*Eurytaphria lilacina*, Warr., l. c., viii, p. 36 . Borneo.
*Ainsographe dissimilis*, Warr., l. c, iv, p. 254, pl. 5, f. 1, 2 . . . . . Mackay.
*Xylinophylla ochrea*, Warr., l. c., v, p. 430 . Key.
*Heterodisca scardamiata*, Warr., l. c., iii, p. 415 Humboldt Bay.
*Azelinopsis externa*, Warr., l. c., iii, p. 144 . Mackay.
*Corymica flavimaculata* ♂ (nec ♀), Warr., l. c., vi, p. 63 . . . . Penang.
*Hyposidra nigricosta*, Warr., l. c., iii, p. 416 . Batchian.
„ *nivitacta*, Warr., l. c., iv, p. 257 . Bonthain.
„ *unimacula*, Warr., l. c., p. 258 . Palawan.
*Gonophaga albipuncta*, Warr., l. c., vi, p. 357. Ron. Isl.
„ *subpulchra*, Warr., l. c., iv, p. 400 Mackay.
*Mimomiza annulata*, Warr., l. c., vi, p. 358 . S. Flores.
*Petelia* (?) *inconspicua*, Warr., l. c., iii, p. 400. Geraldton.
*Petrodava sordida*, Warr., l. c., p. 413 . . Humboldt Bay.
„ (?) *nigripuncta*, Warr., l. c., iv, p. 111 Australia.
*Fascellina papuensis*, Warr., l. c., v, p. 37 . German N. Guinea.
„ *albidiscata*, Warr., l. c., i, p. 446 . Padang.
*Osteodes semicolor*, Warr., l. c., ii, p. 133 . Loochoo Isl.
*Metoxydia delineata*, Warr., l. c., i, p. 442 . Gunong Ijan.

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| *Heteromiza unilinea*, Warr., l. c., iv, p. 256, pl. 4, f. 18 . . . . . | S. Celebes. |
| *Erynnis deminuta*, Warr., l. c., i, p. 442 . . | Padang. |
| *Callerynnis clathrata*, Warr., l. c., ii, p. 139 . | Padang. |
| *Hygrochroa punctifera*, Warr., l. c., i, p. 444 . | No locality. |
| „ *versicolor*, Warr., l. c., i, p. 444 . | Padang. |
| *Mesaster albidiscata*, Warr., l. c., ii, p. 145 . | Padang. |
| *Corotia* (?) *ambigua*, Warr., l. c., v, p. 253 . | Penang. |
| *Zancloptera subusta*, Warr., l. c., viii, p. 37 . | Nias. |
| *Œnochlora imperialis*, Warr., l. c., iii, p. 345 . | Cedar Bay. |

Subfamily *MACARIINÆ*.

Luxiaria acutaria.

*Boarmia acutaria*, Snellen, Tijd. v Ent., xx, p. 75, pl. 6, f. 1, 2 (1877),
*Luxiaria calida*, Warr., Nov. Zool., iii, p. 410 (1896).

Type, Sumatra in coll. Snellen.
Type (*calida* ♂), Java in coll. Rothschild.

I believe this is only a form of the very variable *L. contigaria*, Walk.

Nadagarodes inexactata.

*Acidalia inexactata*, Walker, xxiii, 770 (1861).
*Nadagarodes inexactata*, Swinh., Cat. Het. Mus. Oxon., ii, p. 265 (1900).
*Luxiaria* (?) *straminea*, Warr., Nov. Zool. iii, p. 303 (1896).
*Nadagarodes straminea*, Warr., l. c., p. 411.
*Luxiaria punctata*, Warr., l. c., p. 411.
*Luxiaria ditrota*, Meyrick, Trans. Ent. Soc., 1897, p. 76.

Type ♀, Sarawak in O. M.
Types (*straminea* ♂ ♀), Amboina and Fergusson Isl. in coll. Rothschild.
Type (*punctata* ♀), Java in ditto.
Type (*ditrota* ♀), Sambawa in coll. Elwes.

Euippe undulataria.

*Numeria undulataria*, Pag., J. B. Nass. Ver., 1886, p. 160, pl. 10, f. 1.
*Euippe phalarata*, Swinh. (nec Meyrick), Cat. Het. Mus. Oxon., ii, p. 266 (1892).
*Luxiaria fictarta*, Walker, MS. in Mus. Oxon.

Sarawak (*R. Shelford*), Perak, Singapore.
In O. M. from Sarawak and Singapore.
It is allied to *phalarota*, Meyrick (which is also in the B. M.), but is quite distinct.

EUIPPE SUBNUBILA, nov.

♂. The ground colour is ochreous white, but the body and wings are so thickly covered with greyish-brown irrorations as to give that colour the general appearance, these irrorations are in parts packed together, forming transverse bands; the fore-wings have an inner line well rounded outwardly before reaching the costa, a middle line, a discal indistinct line, apparently outwardly angled below the costa, a rather broad indistinct discal band, a black spot in the upper disc towards apex, a submarginal sinuous whitish line and ochreous cilia, marginal black lunules, costa with some black and some ochreous spots towards apex; hind-wings with an antemedial straight line, a double discal band, margined inwardly by an ochreous sinuous line and outwardly by a submarginal sinuous white line, with a white space between the bands, cilia ochreous, outer margin highly crenelate with black minute points; on the underside the irrorations are very marked and the discal bands dark and distinct.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* KAPAUR, N. Guinea (*Doherty*).

MACARIA ELEONORATA.

*Macaria eleonorata*, Guen., Phal., ii, 89, 1062 (1857).
*Macaria nora*, Walker, xxiii, 934 (1861).
*Macaria neonora*, Walker, xxiii, 934.
*Gubaria amplata*, Warr., Nov. Zool., iii, p. 410 (1896).
*Gubaria nivcostriga*, Warr., l. c.
*Gubaria fluidata*, Warr., l. c., iv, p. 108 (1897).
*Gubaria biflava*, Warr., l. c., viii, p. 35 (1900).

Guenée's type came from Java.

Type (*nora*), N. India in B. M.
Type (*neonora*), Philippines in B. M.
Types (*amplata* ♂♀), Dili and Oinainisa in coll. Rothschild.
Type (*nivcostriga* ♂), Dili in ditto.
Type (*fluidata* ♀), Penang in ditto.
Type (*biflava* ♂), Great Banda in ditto.

All forms of one species, not always local forms. I have received nearly all the forms from Assam; it is in the

O. M. from Timor and the Celebes, and I have it also from Jelebu and Padang.

MACARIA VASUDEVA.

*Macaria vasudeva*, Walker, xxiii, 930 (1861).
*Macaria hebesata*, Walker, xxiii, 931.
*Macaria sinicaria*, Walker, xxvi, 1650 (1862).
*Macaria breviusculata*, Walker, xxvi, 1650.
*Macaria proditaria*, Brem., Lep. Ost.-Sib., p. 81, pl. 7, f. 7 (1864).
*Macaria vivida*, Walker, xxxv, 1657 (1866).
*Macaria maligna*, Butl., Ann. Mag. N. H. (5), i, p. 405 (1878).
*Azata flexilinea*, Warr., Nov. Zool., iv, p. 251 (1897).

Type, Ceylon in B. M.
Type (*hebesata*), N. India in B. M.
Types (*sinicaria* and *breviusculata*), China in B. M.
Type (*vivida*), Flores in O. M.
Type (*maligna*), Yokohama in B. M.
Type (*flexilinea* ♀), W. China in coll. Rothschild.

A variable and widely-spread species. Warren's *flexilinea* is similar to Walker's *sinicaria*.

MACARIA AVITUSARIA.

*Evarzia avitusaria*, Walker, xx, 274 (1860).
*Evarzia odataria*, Swinh., Trans. Ent. Soc., 1890, p. 209, pl. 2, f. 17.

Type, Sarawak in O. M.
Type (*odataria*), Shillong in B. M.

After examining a long series of these forms I feel they cannot be separated.

MACARIA LAUTUSARIA, nov.

♂. Uniform violaceous brown, wings striated with blackish-brown, transverse lines dark red-brown, 1st antemedial outwardly curved below the costa, 2nd discal slightly sinuated on hind-wings, 3rd discal on fore-wings running parallel to 2nd, submarginal on hind-wings running nearly even with the outer margin, marginal line black, cilia black, edged inwardly and outwardly with ochreous, and with black outward knobs; costa of fore-wings with ochreous and black spots towards apex; underside orange ochreous, striated sparsely with brown, lines and cilia more or less as above.

Expanse of wings $1\frac{2}{16}$ inches.

*Hab.* SUMATRA (*de Nicéville*); PENANG (*S. S. Flower*).

Semiothisa isospila.

*Macaria isospila*, Meyrick, Trans. Ent. Soc., 1889, p. 501.
*Semiothisa albidulata*, Warr. Nov. Zool., v, p. 252 (1898).

Type, New Guinea in coll. Meyrick.
Type (*albidulata* ♂), Sumba in coll. Rothschild.

Tephrina disputaria.

*Eubolia* (?) *disputaria*, Guen., Phal., ii, 489, 1710 (1857).
*Diastiatis disputaria*, Swinh., Cat. Het. Mus. Oxon., ii, p. 272 (1900).
*Tephrina subocellata*, Warr., Nov. Zool., iii, p. 413 (1896).

Guenée's type came from Egypt.

Type (*subocellata* ♂), Sheik Othman, near Aden, in coll. Rothschild.

This species is very widely distributed. It seems everywhere to be very common, and is always more or less variable. It has been described by Walker under five different names and by others under seven, and Butler described it from Aden as *sublimbata* in P. Z. S., 1884, p. 502.

Genus Tephrinopsis, Warr., Nov. Zool., iii, p. 412 (1896).

Tephrinopsis frugaliata.

*Macaria frugaliata*, Guen., Phal., ii, 78, 1031 (1857).
*Macaria peremptaria*, Walker, xxiii, 929 (1861).
*Macaria cacavena*, Walker, xxiii, 930.
*Aspilates parallelaria*, Walker, xxv, 1680 (1862).
*Tephrinopsis lineata*, Warr., Nov. Zool., vi, p. 356 (1899).

Guenée's type came from Central India.

Type (*peremptaria*), S. India in B. M.
Types (*cacavena* and *parallelaria*), Ceylon in B. M.
Type (*lineata* ♂), Penang in coll. Rothschild.

*Lineata* is identical with Walker's type of *peremptaria*.

Tephrinopsis gratiosa, nov.

♂. Head and body white, thorax irrorated with brown atoms and with a brown band at its base, abdomen with pale ochreous brown

bands; wings with the base white, irrorated with brown atoms, fore-wings with a brown outwardly-curved band before the middle, both wings with a brown medial straight band, then a white band, then a broad brown band, inwardly lined with black, outwardly with white, a marginal brown band and white cilia with brown patches on the fore-wings; underside ochreous white with broad medial and discal orange-brown bands.

Expanse of wings 1 inch.

*Hab.* ROCKHAMPTON, Queensland.

Can be distinguished from *T. perviaria*, Led., by its inner curved band of fore-wings and its well-defined discal band on both wings.

Not in B. M.

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| * *Nadagarodes flavipectus*, Warr., Nov. Zool., vi, p. 59 . . . . . | Solomons. |
| *Nadagara irretracta*, Warr., l. c., p. 356 . . | Solomons. |
| *Calletæra sordida*, Warr., l. c., iii. p. 303 . . | Fergusson Isl. |
| *Loxographe fulva*, Warr., l. c., v, p. 252 . . | Brisbane. |
| *Gubaria albimedia*, Warr., l. c., iii, p. 409 . . | S. Java. |
| ,, *tricolorata*, Warr., l. c. ii, p. 134 . . | Engano. |
| *Peridela triumbrata*, Warr., l. c., iv, p. 111 . | Penang. |
| *Gonodela perconfusa*, Warr., l. c., iii, p. 409 . | Dili. |
| *Acadra ancillata*, Warr., l. c., vi, p. 57 . . | Goodenough Isl. |
| ,, *tessellata*, Warr., l. c. . . . . | Dorey. |
| *Azata tenuilinea*, Warr., l. c. vii, p. 115 . . | Penang. |
| ,, *mutabilis*, Warr., l. c., iv, p. 104 . . | Penang. |
| ,, *variegata*, Warr., l. c., iii, p. 302 . . | Fergusson Isl. |
| ,, *funebris*, Warr., l. c., vi, p. 354 . . | Milne Bay. |
| ,, *luteiceps*, Warr., l. c., iv, p. 251 . . | Tawaya, Celebes. |
| *Evarzia deformis*, Warr., l. c., iii, p. 408 . . | Batchian. |
| ,, *tripunctata*, Warr., l. c., vi, p. 355 . | S. Flores. |
| *Orthotmeta dentata*, Warr., l. c., iii, p. 304 . | Fergusson Isl. |
| *Semiothisa angustimargo*, Warr., l. c., p. 411 . | Timor. |
| ,, *subcastanea*, Warr., l. c., p. 412 . | Java. |
| *Fidonia albigrisea*, Warr., l. c., iii, p. 407 . . | W. Java. |
| ,, *strigosata*, Warr., l. c., iv, p. 100 . . | Luzon. |
| *Thamnonoma insularis*, Warr., l. c., iii, p. 113 . | Lifu. |
| *Tephrinopsis congener*, Warr., l. c., iv, p. 413 . | Luzon. |
| ,, *munda*, Warr., l. c., iii, p. 412 . | Sumba. |

* *Bulonga* on type label.

Subfamily *BOARMIINÆ.*

AMRAICA SEMIFUSCA.

*Amraica recursaria ab semifusca,* Warr., Nov. Zool., vi, p. 348 (1899).

Type ♀, Dammer Isl. in coll. Rothschild.

I think when the male is obtained, this will be found to be a good form and not an aberration: it is not in the B. M.

BLEPHAROCTENUCHA ALBESCENS.

*Blepharoctenucha albescens,* Warr., Nov. Zool., iii, p. 400 (1896).

Types ♂ ♀, marked Java merid. 1500–1891 (*H. Fruhstorfer*) in coll. Rothschild.

These are South American insects with wrong locality labels on them. There is a female in the B. M. registered San Pedro, Honduras (Fruhstorfer), which is probably the correct locality; they have not the appearance of Eastern insects.

CUSIALA DECURSARIA.

*Boarmia decursaria,* Walker, xxi, 384 (1860).
*Cusiala decursaria,* Swinh, Cat. Het. Mus. Oxon., ii, p. 277, pl. 5, f. 3 (1900).
*Iulotrichia buzurata,* Warr., Nov. Zool., i, p. 429 (1894).
*Cusiala semiumbrata,* Warr., l. c., iii, p. 298 (1896).
*Cusiala semialbida,* Warr., l. c., p. 401.

Type ♂, Sarawak in O. M.
Type (*buzurata* ♂), Oinainisa in coll. Rothschild.
Type (*semiumbrata* ♂), Fergusson Isl. in ditto.
Type (*semialbida* ♂), Batchian, ditto.

There is a nice series in the B. M., some nearly white and free of markings as in *buzurata,* and others more or less covered with black markings; it shows great variation.

BUZURA INSULARIS.

*Blepharoctenia insularis,* Warr., Nov. Zool., i, p. 428 (1894).
*Buzura nephelistis,* Meyrick, Trans. Ent. Soc., 1897, p. 77.

*Buzura atomaria*, Warr. l. c., iv, p. 244 (1897).

Type ♀, Nias in coll. Rothschild.
Type (*nephelistis* ♂), Talaut in B. M.
Type (*atomaria* ♂), Tawaya, Celebes, in coll. Rothschild.

The last two, both males, are identical, and there cannot be any doubt that *insularis* is the female of the same thing.

Genus Zygoctenia, Warr., Nov. Zool., ii, p. 128 (1895).

Zygoctenia singularis, nov.

♂. Antennæ with bristles and cilia on one side to three-fourths its length, and closely packed pile-like short bristles on the other, otherwise neuration, etc., as in *Amblychia*. Antennæ blackish-brown, head, body, and wings red-brown irrorated with black atoms, some black marks on costa of fore-wings, a black dot at the end of each cell in both wings, an interior line outwardly curved on fore-wings, a discal outwardly curved similar blackish line across both wings, this line being marked with black points making it look dentated outwards; and on this line in the lower disc is a smudge-like mark of white; marginal line blackish-brown, cilia grey.

Expanse of wings 2½ inches.

*Hab.* Fergusson Isl. (*A. S. Meek*), two examples.

It has a most marvellous resemblance to *Gyadroma testaceata*, Moore, from India, in shape, colour, markings and general appearance; but its different antennæ and rounded form of the hind-wings mark its distinctiveness.

Elphos hymenaria.

*Elphos hymenaria*, Guen., Phal., i, p. 285, pl. 16, f. 4 (1857).
*Elphos albifascia*, Warr., Nov. Zool., i, p. 430 (1894).
*Elphos mœsta*, Warr., l. c.
*Elphos procellosa*, Warr., l. c., p. 431.

Guenée's type came from Central India.

Type (*albifascia* ♂), Gunong Ijan in coll. Rothschild.
Type (*mœsta* ♂), Gunong Ijan in ditto.
Type (*procellosa* ♂), Assam in ditto.

All varieties which occur everywhere.

Genus PARADROMULIA, Warr., Nov. Zool., iii, p. 300 (1896).

PARADROMULIA AMBIGUA.

*Paradromulia ambigua*, Warr., l. c., p. 301.
„ *ab maculata*, Warr., l. c.
„ *ab rufigrisea*, Warr., l. c.
*Ectropis nigrocellata*, Warr., l. c., vi, p. 54 (1899).

Types ♂ ♀ and aberrations, Fergusson Isl. in coll. Rothschild.

Type (*nigrocellata* ♀), Suer Mefor in ditto.

Not in B. M.

Genus VISITARA, nov.

Antennæ of male with long cilia, all but a small portion broken off, of female quite simple, costa of fore-wings slightly arched, apex not acute, outer margin nearly straight, hinder margin of male slightly rounded, of female straight, hind-wings with the outer margin produced into a short tail at vein 6, otherwise rounded, anal angle acute, hind-wings with veins 3 and 7 commencing at some little distance before the lower and upper angles of the cell.

VISITARA BRUNNEIPLAGA, nov.

♂ ♀. Pale grey-pink, head and thorax dark brown-pink, abdomen pink-grey ; fore-wings with a dark brown-pink patch occupying the basal third and limited by a duplex darker band, which is twice angled outwardly, the patch and band sprinkled with blue iridescent speckles ; an erect duplex discal brown-pink band, with an inner pale line with blue speckles and brown marginal line ; hind-wings also with a brown marginal line and a broad greyish-brown discal suffused band, which narrows to the abdominal margin, a black spot at the end of each cell of both wings ; underside ochreous yellow, a black dot at the end of each cell, a broad black discal band across both wings, terminating abruptly at vein 6 on fore-wings and narrowing on hind-wings to the anal angle.

Expanse of wings $1\frac{9}{10}$ inches.

*Hab.* ♂ SUMATRA, ♀ SANDAKAN, Borneo.

ECTROPIS DECURSARIA.

*Tephrina decursaria*, Walker, xxvi, 1659 (1862).
*Ectropis decursaria*, Swinh., Cat. Het. Mus. Oxon., ii, p. 287, pl. v, f. 21 (1900).
*Ectropis petras*, Meyrick, Trans. Ent. Soc., 1897, p. 75.

Type, Sarawak, Borneo, in O. M.

Type (*petras*), Pulo Laut, Borneo, in B. M.

Ectropis semiparata.

*Acidalia semiparata*, Walker, xxiii, 764 (1861).
*Acidalia illepidaria*, Walker, xxiii, 765.
*Diplurodes indentata*, Warr., Nov. Zool., iv, p. 193 (1897).
*Myrioblephara pustulata*, Warr., l. c., vii, p. 114 (1900).

Type, Sarawak, in O. M.
Type (*illepidaria*), ditto.
Type (*indentata* ♂), Penangah in coll. Rothschild.
Type (*pustulata* ♂), Penang in ditto.

Ectropis fractaria.

*Tephrosia fractaria*, Guen., Phal., i, 270–424 (1857).
*Hypochroma dissentanea*, Walker, xxi, 442 (1860).
*Hypochroma dissonata*, Walker, xxi, 443.
*Tephrosia scitiferata*, Walker, Char. Undescr. Lep. Het., p. 77 (1869).
*Tephrosia fulgurigera*, Walker, l. c.
*Boarmia nigraria*, Feld., Reise Nov., pl. 126, f. 1 (1874).

Guenée's type came from Australia.

Type (*dissentanea*), Tasmania in B. M.
Type (*dissonata*), Australia in B. M.
Types (*scitiferata* ♀ and *fulgurigera* ♀), Australia in Melbourne Mus.
Type (*nigraria*), Sydney in coll. Rothschild.

Walker's description clearly shows that the two types in Mus. Melbourne are merely varietal females of this variable species.

Ectropis terrestris, nov.

♂ ♀. Head, body, and wings ochreous grey, the ground colour is really white, densely packed with very minute ochreous brown irrorations; frons white, abdomen with a brown band on second segment; fore-wings with an interior outwardly curved blackish line, a medial similar line; hind-wings with a discal line, all these lines with black dentate like points, both wings with sinuous white line and black marginal spots, a brownish indistinct patch in the middle of the disc of fore-wings; underside uniform grey, no markings.

Expanse of wings ♂ $1\frac{7}{10}$, ♀ 2 inches.

*Hab.* Hong Kong. Three pairs.

Genus CARECOMOTIS, Warr., Nov. Zool., iii, p. 402 (1896).

CARECOMOTIS PUPILLATA.

*Boarmia pupillata*, Walker, xxi, 491 (1860).
*Opthalmodes pupillata*, Swinh., Cat. Het. Mus. Oxon., ii, p. 285, pl. 5, f. 2 (1900).
*Carecomotis perfumosa*, Warr., l. c.

Type, Sarawak, Borneo, in O. M.
Types (*perfumosa* ♂ ♀), Cedar Bay in coll. Rothschild.
Not in B. M.

ECTROPIDIA EXPRIMATA.

*Acidalia exprimata*, Walker, xxiii, 764 (1861).
*Ectropidia exprimata*, Swinh., Cat. Het. Mus. Oxon., ii, p. 288, pl. 5, f. 11 (1900).
*Ectropidia fimbripedata*, Warr., Nov. Zool., vii, p. 114 (1900).

Type, Sarawak in O. M.
Type (*fimbripedata* ♂), Gunong Ijan in coll. Rothschild.

ASCOTIS SELENARIA.

*Geometra selenaria*, Schiff., Wien. Verz., 101, 7 (1776).
*Ascotis sordida*, Warr., Nov. Zool., i, p. 435 (1894).

Type (*sordida*), Corea in coll. Rothschild.

One of the innumerable forms of the widely distributed *selenaria*.

BOARMIA ACACIARIA.

*Boarmia acaciaria*, Boisd., Faun. Ent. Madag. Lep., p. 116, pl. 16, f. 4 (1834).
*Boarmia alienaria*, Walker, xxi, 370 (1860).
*Boarmia processaria*, Walker, xxi, 372.
*Boarmia gelidaria*, Walker, xxvi, 1537 (1862).
*Boarmia illustraria*, Walker, xxvi, 1539.
*Boarmia concentraria*, Snellen, Tijd. v. Ent., xix, p. 40, pl. 3, f. 20 (1877).
*Chogada fraterna*, Moore, Lep. Atk., p. 245 (1888).
*Opthalmodes minutaria*, Leech, Entom. Suppl., p. 43 (1891).

Boisduval's type came from Madagascar.

Type (*alienaria*), Silhet in O. M.
Type (*processaria*), Maulmein in B. M.
Type (*gelideria*), Canara in B. M.
Type (*illustraria*), Moreton Bay in B. M.

Type (*concentraria*), Sumatra in coll. Snellen.
Type (*fraterna*), Darjiling in coll. Staudinger.
Type (*minutaria*), Loochoo in B. M.

Boarmia inflexaria.

*Boarmia inflexaria*, Snellen, Tijd. v. Ent., xxiii, p. 72, pl. 8, f. 5 (1881).
*Boarmia epistictis*, Meyrick, Trans. Ent. Soc., 1889, p. 499.
*Boarmia repetita*, Butl., Ann. Mag. N. H. (5), x, p. 231 (1882).
*Chogada epistictis ab fasciata*, Warr., Nov. Zool., iii, p. 299 (1896).
„ *ab semialba*, Warr., l. c.
„ *ab rufigrisea*, Warr., l. c.
„ *ab suffusa*, Warr., l. c.
„ *ab flavifasciata*, Warr., l. c., vi, p. 52 (1899).

Type, Celebes in coll. Snellen.
Type (*epistictis*), N. Guinea in coll. Meyrick.
Type (*repetita*), Duke of York Island in B. M.
Types (*fasciata* ♂, *rufigrisea* ♀, *suffusa* ♀), Kiriwini, Trobriand Isl., in coll. Rothschild.
Type (*semialba* ♂), Fergusson Isl. in ditto.
Type (*flavifasciata* ♀), St. Aignan in ditto.

Boarmia compactaria.

*Boarmia compactaria*, Walker, xxvi, 1538 (1862).
*Chogata vittata*, Warr., Nov. Zool., p. 349 (1899).

Type, Penang in B. M.
Type (*vittata* ♀), Rossell Isl. in coll. Rothschild.

A very variable insect; there are also examples in the B. M. from Sandakan and Ceylon, in the O. M. from Singapur, and in my own coll. from Perak and from Aberdeen, Andaman Isls., collected by Wimberly.

Boarmia invenustaria.

*Amphidasys invenustaria*, Leech, Entom. Suppl., p. 43 (1891).
*Alcis molata*, Warr., Nov. Zool., viii, p. 32 (1901).

Type, Japan in B. M.
Type (*molata* ♂), Yokohama in coll. Rothschild.

Warren's type is only a small example of Leech's species; some of Leech's series now in the B. M. are identical.

BOARMIA DISPLICENS.

*Boarmia displicens*, Butl., Ann. Mag. N. H. (5), i, p. 395 (1878).
*Alcis faustinata*, Warr., Nov. Zool., iv, p. 246 (1897).

Type, Yokohama in B. M.
Type (*faustinata* ♂), W. China in coll. Rothschild.

BOARMIA DEFINITA.

*Boarmia definita*, Butl., Trans. Ent. Soc., 1881, p. 407.
*Alcis nigrifumata*, Warr., Nov. Zool., viii, p. 199 (1901).

Type, Japan in B. M.
Type (*nigrifumata* ♂), Nippon in coll. Rothschild.

BOARMIA INOFFENSA, nov.

♂ ♀. Top of head pinkish-grey, body brown, wings with ground colour pinkish-grey, much suffused with brown in parts, leaving a patch on costa, another on outer margin, and the greater part of the lower interior of the fore-wings pinkish-grey, and of the hind-wing only a small part here and there, a lunular mark at the end of each cell, fore-wings with ante and post medial outwardly curved sinuous lines, pale with brown margins; hind-wings with a similar discal line, both wings with a submarginal line; outer margin with black spots; underside white with a very large black patch at end of cell of fore-wings and a black spot on the hind-wings, both wings with very broad black marginal band containing a white spot on each margin below the middle.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* JAVA.

It is allied to *B. compactaria*, Walker, and stands in the B. M. as *B. inoffensa*, Warr., but I can find no reference.

BOARMIA DELIKA, nov.

♂. Antennæ, palpi, head, and body blackish-brown, a grey stripe on the thorax in front; fore-wings chocolate-red, hind-wings chocolate-brown, smeared in parts with violaceous white, on the fore-wings it gives the appearance of a whitish surface with chocolate bands and spots, many spots on the costa of various sizes, three very irregular macular bands interior, central and discal, some of the spots in the discal band joined to similar spots on the outer margin, the discal band includes a brown line; almost the entire space on the hinder margin chocolate-red. Hind-wings with the base

violaceous white as is also the lower third, these spaces are traversed by irregular brown lines and markings, the central space, right across the wing to the apex dark brown ; underside dull grey, costa of fore-wings with ochreous spots, both wings with four central bands close together.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* Sandakan, N.E. Borneo (*W. B. Pryer*).

Boarmia lectonia, nov.

♂ ♀. Greyish-white, densely irrorated with minute brown atoms, frons white with a brown spot, abdomen with dorsal brown spots in pairs on each segment; fore-wings with an interior outwardly curved brown line, the space inside it dark, a medial brown line, a duplex discal crenelated line ; hind-wings with an interior line and a duplex middle line ; all the lines on fore-wings commencing with brown patches on the costa ; both wings with submarginal white crenelated line, the space to the margin dark, with black marginal points, a black dot at end of each cell ; underside grey, palpi below and pectus white, cell dots, ante and post-medial lines, an ochreous apical patch and ochreous cilia with brown patches.

Expanse of wings ♂ $1\frac{1}{2}$, ♀ $1\frac{7}{10}$ inches.

*Hab.* Japan, one male and three females.

Boarmia costaria.

*Boarmia costaria*, Guen., Phal., i, 242, 361 (1857).
*Serraca spissata*, Warr., Nov. Zool., vi, p. 56 (1899).

Guenée's type came from Sarawak.

Type (*spissata* ♂), Nias in coll. Rothschild.

*Spissata* is merely a melanistic form of *costaria*.

Abaciscus pannosaria.

*Cleora pannosaria*, Moore, P. Z. S., 1867, p. 629.
*Diplurodes contacta*, Warr., Nov. Zool., vi, p. 53 (1899).

Type, Bengal in coll. Russell.

Type (*contacta* ♂), Arjuno, Java, in coll. Rothschild.

I can see no difference, *pannosaria* is not uncommon in Assam.

Genus Symmetroctena, Warr., Nov. Zool., ii, p. 127 (1895).
Lipogya, Warr., l. c., v, p. 249 (1898).

Symmetroctena exprimataria.

*Larentia exprimataria*, Walker, xxvi, 1704 (1862).
*Lipogya exprimataria*, Warr., l. c.

*Symmetroctena fumosa*, Warr., l. c., ii, p. 128.

Type, without locality in B. M.
Type (*fumosa* ♂), Queensland in coll. Rothschild.

In the B. M. this is under Genus *Smyriodes*, but *aplectaria*, Guen., the type species, is something quite different. Meyrick put it in the Genus *Selidosena* = *Boarmia*, but as Warren points out it has no fovea.

Genus Sysstema, Warr., Nov. Zool., vi, p. 57 (1899).

Sysstema microdoxa.

*Diastictis microdoxa*, Meyrick, Trans. Ent. Soc., 1897, p. 75.
*Sysstemia farinosa*, Warr., l. c., p. 353.

Type, Pulo Laut in B. M.
Type (*farinosa* ♂), Ron Isl. in coll. Rothschild.

Xenosina eremias.

*Selidosema eremias*, Meyrick, Pr. Linn. Soc., N.S.W. (2), vi, p. 600 (1891).
*Xenosina detrita*, Warr., Nov. Zool., vii, p. 115 (1900).

Type, New South Wales in Sydney Mus.
Type (*detrita* ♂), Strathfield, New South Wales, in coll. Rothschild.

Phelotis excursaria.

*Tephrosia excursaria*, Guen., Phal., i, 267, 416 (1857).
*Tephrosia phibalapteraria*, Guen., l. c., 268, 417.
*Hemerophila vestita*, Walker, xxi, 322 (1860).
*Boarmia attributa*, Walker, xxi, 390.
*Tephrosia subtinctaria*, Walker, xxi, 415.
*Boarmia decertaria*, Walker, xxi, 391.
*Eubyja turpis*, Warr., Nov. Zool., vi, p. 49 (1899).

Guenée's types came from Australia.

Type (*vestita*), Tasmania in B. M.
Types (*attributa* and *decertaria*), Sydney in B. M.
Type (*subtinctaria*), Australia in B. M.
Type (*turpis* ♀), S. Flores in coll. Rothschild.

Genus Anticypella, Meyrick, Trans. Ent. Soc., 1892, p. 108.

Anticypella diffusaria.

*Medasina diffusaria*, Leech, Ann. Mag. N. H. (6), xix, p. 432 (April 1897).

*Nychiodes gigantaria*, Staud., Iris, x, p. 48, pl. 1, f. 32 (1897).
*Anticypella gigantaria*, Meyrick, l. c.

Type, Central China in B. M.
Type (*gigantaria*), Amur in coll. Staudinger.

Staudinger wrote the description of his species in 1891 and printed the name in his lists, but his paper was not published until late in 1897.

Parathemis canescaria.

*Boarmia canescaria*, Guen., Phal., i, 249, 380 (1857).
*Parathemis irrorata*, Warr., Nov. Zool., v, p. 250 (1898).
*Parathemis violescens*, Warr., l. c.

Guenée's type came from New Holland.

Types (*irrorata* ♂ and *violescens* ♂ ♀), Dawson, Queensland, in coll. Rothschild.

It is also from Queensland in the B. M.; the species is variable, *irrorata* and *violescens* are merely ordinary varietal forms.

Duliophyle majuscularia.

*Boarmia majuscularia*, Leech, Ann. Mag., N. H. (6), xix, p. 420 (1897).
*Duliophyle agitata ab diluta*, Warr., Nov. Zool., vii, p. 113 (1900).

Type, Japan in B. M.
Type (*diluta* ♂), Japan in coll. Rothschild.

Proteostrenia occulta.

*Proteostrenia lida ab occulta*, Warr., Nov. Zool., viii, p. 200 (1901).

Type ♂, Nippon in coll. Rothschild.

I believe this to be a good form and not an aberration; it is not in the B. M.

Laophila fokia, nov.

♂ ♀. Dark grey, densely irrorated with minute brown atoms, colour uniform; wings with a black dot at the end of each cell and dark grey transverse lines, all more or less slightly sinuous and slightly curving outward; fore-wings with the 1st at one-fourth, 2nd in the middle, well curved round the cell dot, this line runs across

the hind-wings at one-third, both wings with discal line containing minute black points, and between this and the margin are two or three indistinct lines, all the lines more apparent in the female than in the male, marginal points black and very minute; underside paler without irrorations, the discal lines only indicated.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* S.E. Australa (Raynor coll.).

Laophilia modesta, nov.

♂. Dark grey, with a slight ochreous tinge; wings with a black dot at the end of each cell, fore-wings with an indistinct interior grey line, both wings with two discal lines rather close together, wider apart on the hind than on the fore-wings, the inner of these two lines slightly sinuous, the outer somewhat dentated, a submarginal similar line, the margin itself darker than the rest of the wings; underside paler, the hinder marginal space of fore-wings and the inner portions of the hind-wings nearly white, a discal row of minute grey points, cilia dark and glazed.

Expanse of wings 1 inch.

*Hab.* S.E. Australia (Raynor coll.).

Chlenias banksiaria.

*Chlenias banksiaria*, Le Guillon, Rev. Zool., 1841, p. 257.
„ „ Guen., Phal., ii, p. 239 (1857).
*Chlenias acutaria*, Guen., l. c., pl. 14, f. 1.
*Chlenias indecisata*, Walker, xxiv, 1153 (1862).
*Asteroscopus nodosus*, Swinh., Cat. Het. Mus. Oxon., i, p. 289, pl. 8, f. 13 (1892).

Le Guillon's type came from New Holland.
Guenée's type came from Tasmania.

Type (*indecisata*), Australia in B. M.
Type (*nodosus*), Van Diemen's Land in O. M.

Genus Fisera, Walker, xxi, 291 (1860).
Criomacha, Meyrick, Pr. Linn. Soc., N. S. W., (2) vi, p. 659 (1891).

Fisera perplexata.

*Fisera peplexata*, Walker, xxi, 292.
„ „ Swinh., Cat. Het. Mus. Oxon., ii, p. 275, pl. 7, f. 3 (1900).

*Chlenias belideana*, Feld., Reise Nov. Lep., pl. 124, f. 9 (1874).
*Criomacha belideana*, Meyrick, l. c.

Type, Tasmania in O. M.
Type (*belideana*), Australia in coll. Rothschild.

Not in B. M.

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| *Eubyjodonta concinna*, Warr., Nov. Zool., vi, p. 50. . . . . | Nias. |
| *Cusiala fessa*, Warr., l. c. iii, p. 401 . . | Adonara. |
| ,, *malescripta* (= *bistonaria*, Walk.),* Warr., l. c., iv, p. 90 . . . . | Kalao. |
| *Blepharoctenia perclara*, Warr., vi, p. 49. . | Formosa. |
| *Buzura pura*, Warr., l. c., i, p. 429. . . | S. Celebes. |
| *Maidana pallidiplaga*, Warr., l. c., vi, p. 351 | Sud Est Isl. |
| ,, *ab fumipicta*, Warr., l. c. . . | Rossell Isl. |
| *Elphos subrubida*, Warr., l. c., iii, p. 300 . | Fergusson Isl. |
| *Paradromulia anomala*, Warr., l. c., iv, p. 34 . . . . . | N. Guinea. |
| *Scotopteryx lignicolor*, Warr., l. c., p. 90 . | Lawas, N. Borneo. |
| *Catascia pulverulenta*, Warr., l. c., p. 250 . | Taganat Isl. |
| *Opthalmodes ruficornis*, Warr., l. c., p. 249. | Tawaya and Dongola. |
| *Ectropis præpicta*, Warr., l. c., viii, p. 33 . | Yokohama. |
| ,, *rufibrunnia*, Warr., l. c., vi, p. 350 | Mackay. |
| ,, *macariata*, Warr., l. c., iv, p. 248 . | Cedar Bay. |
| ,, *nigrocellata*, Warr., l. c., vi, p. 54 . | Ron Isl. |
| † ,, *hypochromaria*, Warr., l. c., p. 350 | Milne Bay |
| *Gasterocoma subfasciata*, Warr., l. c., p. 351 | Penang. |
| *Racotis boarmiaria* sub-sp. *rufaria*, Warr., l. c., iv, p. 98 . . . . . | N. Guinea. |
| *Myrioblephara picta*, Warr., l. c., iii, p. 404 | Java. |
| *Cleora trisinuata*, Warr., l. c., v, p. 248 . | N. Guinea. |
| *Alcis* (?) *paucisignata*, Warr., l. c., vi, p. 348 | Gunong Ijan. |
| *Chogada lacteata*, Warr., l. c., iv, p. 247 . | N. Britain. |
| ,, *perlepidaria*, Warr., l. c., vii, p. 112 . . . . . | Geraldton. |
| *Calicha rufiplaga*, Warr., l. c., vi, p. 348 . | Strattfield, N. S. W. |
| *Microtome trigonata*, Warr., l. c., p. 352 . | Rossell Isl. |
| ‡ *Tephrina* (?) *convergens*, Warr., l. c., p. 61 | W. China. |
| *Pachyplocia griseata*, Warr., l. c., iii, p. 404 | Cedar Bay. |
| *Polycrasta ocellata*, Warr., l. c., p. 302 . | Kiriwini. |

* See Cat. Het. Mus. Oxon., ii, p. 277 (1900).
† *Gasterocoma* on type label. ‡ *Paratephra* on type label.

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| *Arctoscelia onusta*, Warr., l. c., iv, p. 102 . | Luzon. |
| „ „ *ab mutata*, Warr., l. c. . | Luzon. |
| *Scioglyptis lithina*, Warr., l c., p. 99 . . | Mackay. |
| „ *semifascia*, Warr., l. c. . . | Humboldt Bay. |
| *Ateloptila confusa*, Warr., l. c., vii, p. 112 . | Cedar Bay. |
| *Pæcilalsis indigna*, Warr., l. c., vi, p. 352 . | Penang. |
| „ *subtincta*, Warr., l. c., iv, p. 96 . | Luzon. |
| *Pseudocoremia flava*, Warr., l. c., iii, p. 406 | N. Zealand. |
| *Polylophodes triangularis*, Warr., l. c. . | Java. |
| *Pseudalcis catoriata*, Warr., l. c., iv., p. 97 . | Pulo Laut. |
| *Mnesigea sinuata*, Warr., l. c., p. 95 . . | Parkside, S. Australia. |
| *Deinotrichia dentigerata*, Warr., l. c., vi, p. 53 | Penang. |
| *Deileptenia maculata*, Warr., l. c., p. 52 . | Penang. |
| *Darisa differens*, Warr , l. c., iv, p. 398 . | Omeishan. |
| „ (?) *marmorata*, Warr., l. c., vi, p. 349 . . . . . | Brown River, Bt. N. Guinea. |
| *Lassaba indentata*, Warr., l. c., iii, p. 403 . | Java. |
| „ *subdecorata*, Warr., l. c., iv, p. 398 . | Omeishan. |

Subfamily *ABRAXINÆ*.

ABRAXAS GROSSULATARIA.

*Phalæna-geometra grossulataria*, Linn., Syst. Nat., i, 2, 867, 242 (1759).

*Abraxas cuneifera*, Warr., Nov. Zool., ii, p. 125 (1895).

Warren's type is without locality, but it is probably from Japan. It is merely a sport of the common European Abraxas; there are examples exactly like it from England ex coll. Leech in the B. M., and also one from Berlin; it is a common insect in Japan.

ABRAXAS LABRARIA.

*Abraxas labraria*, Guen., Phal., ii, 203, 1155 (1857).
*Abraxas circumducta*, Walker, xxxv, 1669 (1866).
*Abraxas discata*, Warr., Nov. Zool., iv, p. 86 (1897).

Guenée's type had no locality.

Type (*circumducta*), Java in B. M.
Types (*discata* ♂ ♀), Pulo Laut in coll. Rothschild.

ABRAXAS BACCATA.

*Abraxas baccata*, Warr., Nov. Zool., v, p. 30 (1898).
*Abraxas confluentaria*, Warr., l. c.

*Abraxas granulifera*, Warr., l. c.

Type ♀, Sambalun, Lombok, in coll. Rothschild.
Type (*confluentaria* ♂), Arjuno, Java, in ditto.

The two last are undoubtedly one and the same species, and I cannot see how the first can be separated from them; there are two in the B. M. from Arjuno, identical with *granulifera*, and another differing from all three.

Abraxas nebularia.

*Abraxas picaria* var. *nebularia*, Leech, Ann. Mag. N. H. (6), xix, p. 447 (April 1897).
*Abraxas semiturpis*, Warr., Nov. Zool., iv, p. 396 (August 1897).

Type, Ta-tsien-lu, W. China, in B. M.
Type (*semiturpis* ♂), Omeishan, W. China, in coll. Rothschild.

A variable form, but quite distinct from *picaria*, Moore, from India.

Abraxas triseriaria.

*Abraxas triseriaria*, Herr-Schäff., Samml. Ausser. Schmett, f. 322 (1850).
*Potera marginata*, Moore, P. Z. S., 1878, p. 852, pl. 53, f. 9.
*Potera intervacuata*, Warr., Nov. Zool., iii, p. 396 (1896).

Herrich-Schäffer's type came from Java.

Type (*marginata*), Moolai in Indian Museum, Calcutta.
Type (*intervacuata* ♂), Mt. Mulu, N. Borneo, in coll. Rothschild.

There are eleven examples from Burma, Java, and Sumatra, all varying a little.

Cistidia chinensis, nov.

♂ ♀. Antennæ black, head and body dark orange ochreous, thorax suffused with black, leaving merely the fore part ochreous, abdomen with large segmental bands above, below, and at the sides, but disconnected from each other; wings black with dull white squarish spots; fore-wings with a large one below the origin of vein 2, one a little smaller at the end of the cell, with two white streaks on the costa above it, an outwardly curved row of discal spots, some short

streaks and marks near the base : hind-wings with a long spot filling the greater part of the middle of the cell, and sub-basal streak below it, a spot beyond it outside the cell, and an outwardly curved row of discal spots ; in some examples there are little black dots inside the white spots.

Expanse of wings 2½ inches.

*Hab.* OMEISHAN, MOUPIN, W. China.

There are four pairs in the B. M. all identical. Mr. Leech, in Ann. Mag. N. H. (6), xix, p. 459 (1897), calls this insect *Vithora indrasana*, Moore, of the form *nigripars*, Swinh. Sir George Hampson (Moths, India, iii, p. 311) says " the markings are very variable," referring to *indrasana*, but Sir George had not enough material to work on. I believe this insect and *nigripars* and *indrasana* to be all good and constant forms. The females are always very similar to the males, but sometimes with more white, not less as Hampson says; there is a male of *indrasana* from Sikhim now in the B. M.

GENUSA BIGUTTA.

*Genusa bigutta*, Walker, iv, 818 (1855).
*Genusa* (?) *destituta*, Walker, xxxii, 341 (1865).
*Genusa simplex*, Warr., Nov. Zool., iv, p. 88 (1897).

Type, N. India in B. M.
Type (*destituta*), Cambodia, Siam, in O. M.
Type (*simplex*), Bongao in coll. Rothschild.

There are only indications of the usual spots in *simplex*, but the spots are a very uncertain character in this species.

Genus CYPRA, Boisd., Voy. de l'Astrolabe, p. 201 (1832).
COZISTRA, Walker, xxxii, 342 (1865).

CYPRA DELICATULA.

*Cypra delicatula*, Boisd., l. c., pl. 1, f. 3.
*Cozistra delicatula*, Swinh., Cat. Het. Mus. Oxon., i, p. 201 (1892).
*Cozistra subnudata*, Walker, xxxii, 342.
*Cozistra membranacea*, Feld., Reise Nov., pl. 104, f. 5 (1874).

Boisduval's type came from New Guinea.

Type (*subnudata*), Batchian in O. M.
Type (*membranacea*), Amboina in coll. Rothschild.

Has heretofore been placed in the Lymantriidæ. I submitted a male to Mr. Meyrick for examination, and he says the insect is a peculiar and much specialised form, but he is clearly of opinion that it is a Boarmid; it has an exceptionally developed fovea near base of hinder margin.

TIGRIDOPTERA MACULOSA.

*Arycanda maculosa*, Walker, vii, 1775 (1856).
*Arycanda absorpta*, Warr., Nov. Zool., iv, p. 82 (1897).

Type ♀, Sumatra in B. M.
Type (*absorpta* ♀), Lawas, N. Borneo, in coll. Rothschild.

TIGRIDOPTERA DECORATA, nov.

♂ ♀. Antennæ, head, thorax, first two segments of the abdomen and both wings of a uniform pale slaty blue, remainder of the abdomen dark chrome yellow, wings with black spots and bands, a large round spot at the end of each cell, fore-wings with some black marks on the costa near the base, a short basal streak, a band from hinder margin near base to the costa before middle, a band from centre of hinder margin to the cell spot, two discal, the inner one macular towards costa, the outer one macular throughout hind-wings, with a basal band corresponding to the first band on fore-wings, also ante and postmedian bands, the latter with a line running close to its outer side, a macular discal band corresponding to the outer discal band of the fore-wings, and both wings with large spots close to the outer margin; the thorax has three transverse bands and the abdomen one on its first segment: the underside is pale slaty blue, the wings with large cell spots and broad marginal borders, the legs and body are of the same colour, the abdomen being more than half covered, the slaty colour ending in a black patch.

Expanse of wings ♂ 1½, ♀ $1\frac{5}{10}$ inches.

*Hab.* MILNE BAY (*A. S. Meek*). Nearest to *T. flexilinea*, Warr.

CRASPEDOSIS ARUENSIS.

*Craspedosis ernestina*, var. *aruensis*, Pag., J. B. Nass. Ver., 1886, p. 164.
*Craspedosis schistacina*, Warr., Nov. Zool., iii, p. 399 (1896).
*Craspedosis leucosticta*, sub-sp. *candidior*, Warr., l. c., vi, p. 47 (1899).

Type, Aru in coll. Pagenstecher.

Type (*schistacina* ♂), New Guinea in coll. Rothschild.
Types (*candidior* ♂ ♀), S. Aignan in ditto.

There are seven examples from Aru and N. Guinea in the B. M., all varying a little one from the other.

CRASPEDOSIS DELICATA, nov.

♂. Head, thorax and first two segments of abdomen slaty black, the centre of the thorax paler, the rest of the abdomen orange-colour, fore-wing with the interior black, the base, costal and outer portions dark slaty colour, a pale streak from the base, a pale streaky patch in the disc from costa beyond the middle containing a thin white streak, a pale discal band from the hinder margin near the angle, to near apex, limiting the black interior space ; hind-wings with the base black, a large white spot or patch on abdominal margin before middle and narrowing upwards and extending to the top of the cell, followed by a slaty blue band then a discal black band, a submarginal slaty blue band and a marginal black band.

Expanse of wings $1\frac{7}{10}$ inches.

*Hab.* ROSSELL ISL., Louisiade (*A. S. Meek*).

Allied to *C. aruensis*, Pag.

POGONOPYGIA NIGRALBATA.

*Pogonopygia nigralbata*, Warr., Nov. Zool., i, p. 681 (1894).
*Pogonopygia nigralbata*, sub-sp. *attenuata*, Warr., l. c., iv, p. 240 (1897).

Type, Khasia Hills in coll. Rothschild.
Type (*attenuata* ♀), Selangore in ditto.

*Attenuata* seems to me to be merely a faded specimen of *nigralbata*, of which there are examples from the Khasia Hills in the B. M.

BRACCA LUCIDA, nov.

♂ ♀. Palpi, head, thorax, and fore-wings purple-brown, three white spots on the thorax in front, fore-wings with an ochreous yellow streak along the centre of the hinder margin, a small white sub-basal spot, a slightly larger white spot in the middle of the cell, a large oval spot across the disc, much larger in the female than in the male, a pale irregular submarginal band with a white spot above, and another below its middle, in the female the upper white spot has a black dot on a pale ground joined to it on its side, and the lower spot has some black dots below it : hind-wings and abdomen bright

ochreous yellow, a broad discal black band, disjointed opposite the cell, a submarginal row of black spots in each interspace, except in the interspace above vein 3.

Expanse of wings ♂ 1½, ♀ 2 inches.

*Hab.* Rossell Isl., Louisiade (*A. S. Meek*).

Differs from *B. bajularia*, Clerck, from Amboina in the prominent white spots on the thorax and the broken thin band of the hind-wings: nearest to *B.* (*Celerena*) *ribbei*, Pag., J. B. Nass. Ver., xxxix, p. 164.

Bursada xanthomelas.

*Climene xanthomelas*, Boisd., Voy de l'Astrolabe, p. 202, pl. 3, f. 10 (1832).
*Bursada quadripartita*, Walker, xxi, p. 190 (1864).
*Bursada percurrens*, Warr., Nov. Zool., viii, p. 32 (1901).

Boisduval's type came from New Ireland.

Type (*quadripartita*), Aru in O. M.
Type (*percurrens* ♀), Teoor in coll. Rothschild.

Local forms differing very slightly from each other.

Bursada salamandra.

*Bursada salamandra*, Kirsch., Mith. Zool. Mus. Dresden, 1877, p. 133, pl. 7, f. 9.
*Bursada pyrifera*, Warr., Nov. Zool., iii, p. 398 (1896).

Type, New Guinea in Mus. Dresden.
Types (*pyrifera* ♂ ♀), Korrido, Dutch New Guinea, in coll. Rothschild.

Bursada maculifera.

*Bursada maculifera*, Feld., Reise Nov., pl. 130, f. 12 (1874).
*Bursada adaucta*, Warr., Nov. Zool., iv, p. 240 (1897).

Type, Moluccas in coll. Rothschild.
Type (*adaucta* ♂), Siao Isl., north of Celebes, in ditto.

I have not seen Felder's type, but Warren's specimen is exactly like Felder's figure.

Bursada obsoleta.

*Bursada invadens ab obsoleta*, Warr., Nov. Zool., vi, p. 45 (1899).

Type, St. Aignan in coll. Rothschild.

A good form and not an aberration.

Bursada interruptata.

*Bursada invadens ab interruptata*, Warr., Nov. Zool., vi, p. 4 (1899).

Type, St. Aignan in coll. Rothschild.

A good form, I believe, and not an aberration.

Bursada placens.

*Bursada placens*, Pag., J. B. Nass. Ver., 1886, p. 60.
*Bursada trispilata*, Warr., Nov. Zool., iv, p. 84 (1897).

Type, N. Guinea in coll. Pagenstecher.
Type (*trispilata*), N. Guinea in coll. Rothschild. Not in B. M.

Bursada colenda, nov.

♀. Antennæ, head, body, and fore-wings deep black, fore-wings with the spots orange-ochreous, a small one near the base, connected by a sub-costal streak, with a larger oval-shaped sub-costal spot before the middle, a large oval upper discal spot quite three times as large as the second spot; hind-wings orange-ochreous with a broad black band on all the margins, deepest on the costa, with an inner projection or bend above the anal angle, narrow in the abdominal margin and attenuated towards base.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* Fergusson Isl. (*A. S. Meek*).

Bursada suspensa, nov.

♀. Head, body, legs, and wings deep black, fore-wings with an ochreous-orange spot in the upper disc, square cut near the costa, with even sides, and rounded at its lower end; hind-wings with a broad ochreous-orange streak from the base occupying the greater portion of the middle of the wing, straight on its upper edge, slightly angled and then rounded at its extremity in the disc, slightly angled again on its lower side.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* Kapaur, N. Guinea (*Doherty*).

It is closely allied to *B. intercisa*, Walker, which is in the B. M., from the same locality.

Bursada curzola, nov.

♂. Frons, top of head and body bright orange-ochreous, thorax with a large black spot in its middle, a thin black band at its base, abdomen with thin black bands on the 3rd, 4th, and 5th segments, the 6th and 7th segments black, two black spots on the ochreous tip; wings black, with large orange-ochreous spots, much as in *maculifera*, Felder, Reise Nov., pl. 130, f. 12, but the yellow spots are larger, making the black bands between them much narrower, and the yellow spot in the centre of the hind-wings is not divided from the spot at the anal angle by a black band, but is one large space occupying the whole central space of the wing.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* Talaut (*Doherty*).

Not in B. M.

| | |
|---|---|
| *Abraxas concinna*, Warr., Nov. Zool., i, p. 421 . . . . . | Thibet. |
| „ *incolorata*, Warr., l. c., p. 419 . | Java. |
| „ *invasata*, Warr., l. c., iv, p. 87 . | Kina Balu. |
| „ *moniliata*, Warr., l. c. . . | S. Celebes. |
| „ *nigriclathrata*, Warr., l. c., iii, p. 394 . . . . . | Java. |
| „ *unisinuata*, Warr., l. c., p. 130 . | Java. |
| „ *comminuta*, Warr., l. c., vi, p. 346 . . . . . | S. Flores. |
| „ *extralineata*, Warr., l. c. . . | Bouru. |
| „ *sesquilineata*, Warr., l. c., p. 347 | Bouru. |
| *Potera albiquadrata*, Warr., l. c., iv, p. 89 | Batchian. |
| „ *flavimacula*, Warr., l. c., iii, p. 395 | Cedar Bay. |
| *Omophyseta albiplaga*, Warr., l. c., i, p. 415 | S. Celebes. |
| **Arycanda discata*, Warr., l. c., iv, p. 83 . | Natuna Isl. |
| * „ *omissa*, Warr., l. c. . . . | Sarawak. |
| „ *evanescens*, Warr., l. c., vi, p. 41 | Sula Mangoli. |
| *Bordeta longimacula*, Warr., l. c. iv, p. 83 | Sattelberg, German N. Guinea. |
| *Craspedosis semiplaga*, Warr., l. c., iii, p. 297 . . . . . | Fergusson Isl. |

* *Panæthia* on type labels.

| | |
|---|---|
| *Craspedosis uniplaga*, Warr., l. c. . . | Fergusson Isl. |
| „ *funebris*, Warr., l. c. . . | Fergusson Isl. |
| „ (?) *bicolorata*, Warr., l. c., p. 398 . | Amboina. |
| „ *leucosticta*, Warr., l. c. . . | Cedar Bay. |
| „ *ovalis*, Warr., l. c., p. 399 . | Humboldt Bay. |
| „ *semilugens*, Warr., l. c. . . | Humboldt Bay. |
| „ *undulosa*, Warr., l. c., i, p. 411 | S. Celebes. |
| „ *albigutta*, Warr., l. c., iv, p. 241 | Etna Bay. |
| „ *galathea*, Warr., l. c., v, p. 33 . | N. Guinea. |
| „ *niveosignata*, Warr., l. c., vi, p. 47 . . . . . | Ron Isl. |
| „ *sibilla*, Warr., l. c., p. 345 . | Halmahera. |
| „ *xanthosoma*, Warr., l. c., p. 346 | Bouru. |
| **Stenocharta picaria*, Warr., l. c., iv, p. 397 | N. Guinea. |
| *Xanthomima seminigra*, Warr., l. c., p. 86 | Kei Tocal. |
| „ *disrupta*, Warr., l. c., vi, p. 48 | Alu, Shortland Isl. |
| „ *biquadrata*, Warr., l. c., p. 346 . . . . | Little Key. |
| *Bociraza latiflava*, Warr., l. c., iii, p. 356 . | Milne Bay. |
| „ „ var. *restricta*, Warr., l. c., vi, p. 324 . . . | Milne Bay. |
| „ *reversa*, Warr., l. c., iv, p. 28 . | Obi. |
| *Bracca flavitænia*, Warr., l. c., vi, p. 44 . | Sula Mangoli. |
| *Bursada bistrigata*, Warr., l. c., iii, p. 396 | Tenimber. |
| „ *hyaloplaga*, Warr., l. c., p. 397 . | Humboldt Bay. |
| „ *oppositata*, Warr., l. c. . . | Humboldt Bay. |
| „ *septemnotata*, Warr., l. c., iv, p. 84 . . . . . | Kina Balu. |
| „ *flavannulata*, Warr., l. c., vi, p. 343 . . . . | Milne Bay. |
| „ *rotundimacula*, Warr., l. c., iv, p. 241, pl. 5, f. 26 . . | Luzon. |
| „ *albicolor*, Warr., l. c., v, p. 32 . | N. Guinea. |
| „ *obnubilata*, Warr., l. c., p. 246 . | Bouru. |
| „ „ ab. *invena*, Warr., l. c., vi, p. 343 . . . | Bouru. |
| „ *atribasalis*, Warr., l. c., p. 45 . | Pulo Bisa, north of Obi. |
| „ *interspilata*, Warr., l. c. . . | St. Aignan. |
| „ *unifascia*, Warr., l. c., p. 46 . | Woodlark Isl. |
| *Bursadopsis basalis*, Warr., l. c., p. 344 . | Obi. |
| „ *præflavata*, Warr., l. c. . . | Sud Est Isl. |

* *Craspedosis* on type label.

## Family MONOCTENIIDÆ.

### Monoctenia vinaria.

*Œnochroma vinaria*, Guen., Phal., i, p. 185, pl. 7, f. 2 (1857).
*Œnochroma pallida*, Warr., Nov. Zool., v, p. 231 (1898).

Guenée's type came from Australia.

Type (*pallida* ♂), Dawson, Queensland, in coll. Rothschild.

*Pallida* is a pale form of this species; there are examples in three or four different shades of colour in the B. M. from the same locality.

### Sarcinodes subfulvida.

*Sarcinodes subfulvida*, Warr., Nov. Zool., iii, p. 280 (1896).
*Sarcinodes compacta*, Warr., l. c., p. 355.

Type ♂, Kiriwini in coll. Rothschild.
Type (*compacta* ♂), Amboina in ditto.

*Compacta* is merely a small form of *subfulvida*.

### Epidesma unilinea, nov.

♂. Pectinations of antennæ black, shaft of antennæ, hind part of thorax, abdomen and ground colour of both wings pinkish-grey: head, fore part of thorax and costal space of fore-wings brown, the colour diffusing inwardly for a little; a black point at end of each cell, a red straight line from middle of abdominal margin of hind-wings to the apex of fore-wings, the inner part of the wing on fore-wings being pale, on the hind-wings the whole inner space is white irrorated with grey, on both wings the whole space outside the line is dark reddish-grey, caused by the density of the red irrorations, marginal points black: underside whitish irrorated with red, a black streak at apex of fore-wings, a dentated brown line running on the outer side of the straight line on hind-wings and some submarginal brown marks, pectus body and legs white.

Expanse of wing, 1½ inches.

*Hab.* Tasmania (*J. J. Walker*), two examples.

These specimens are labelled Hong Kong, but this is evidently an error. Mr. Walker brought most of his specimens from China, but some of them were from Tasmania and the genus *Epidesma* is essentially Australian.

NEARCHA CARONIA, nov.

♂ ♀. Grey irrorated with minute black atoms, palpi black above, white beneath, frons dark brown, top of head whitish ; an ocelloid dark grey spot at the end of each cell, fore-wing with the interior line and exterior band dark grey, the former composed of two dots quite close together on hinder angle one-third from base, with a small dot above it, the discal band is narrow and runs across both wings and is slightly sinuous and more or less diffused inwards, and contains some spots on its outer margin ; the outer margin of both wings is broadly rather darker than the otherwise uniform colour of the wings, the margin has black points, the cilia is concolorous.

Expanse of wings $1\frac{1}{10}$ inches.

*Hab.* PORT DARWIN.

It is nearest to *N. benecristata*, Warr., Nov. Zool., ii, p. 83, from Thursday Island in B. M., but the discal band of fore-wings is more erect and lacks the thick black streak, on the hind-wings the band is discal not medial.

TAXEOTIS INCONCISATA.

*Panagra inconcisata*, Walker, xxiii, 1003 (1861).
*Taxeotis delogramma*, Meyrick, Proc. Linn. Soc., N.S.W., 1890, p. 1146.
*Taxeotis semifusca*, Warr., Nov. Zool., vi, p. 324 (1899).

Type, Australia in B. M.
Type (*delogramma*), Queensland in Mus. Melbourne.
Type (*semifusca* ♀), Queensland in coll. Rothschild.

A very variable insect : Meyrick says abundant everywhere in Australia.

ADEIXIS INOSTENTATA.

*Panagra inostentata*, Walker, xxiii, 1012 (1861).
*Adeixis insignata*, Warr., Nov. Zool., iv, p. 27 (1897).

Type, Moreton Bay in B. M.
Types (*insignata* ♂ ♀), Parkside in coll. Rothschild.

In Proc. Linn. Soc., N.S.W., 1890, p. 1214, Meyrick says *inostentata* is a *Noctuid:* but this is a mistake, and the note Mr. Meyrick carried with him to Australia must have got mixed, because the type of *inostentata* is in the B. M. and is a true *Monoctenid.*

Not in B. M.

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|---|---|
| *Onycodes rubra*, Warr., Nov. Zool., iv, p. 27 . . | Queensland. |
| *Œnochroma simplex*, Warr., l. c., iv, p. 206 . . | Roebourne. |
| ,, *decolorata*, Warr., l. c., iii, p. 554 . | Cedar Bay. |
| ,, *leucospila*, Warr., l. c., v, p. 230 . . | Dawson. |
| *Sarcinodes punctata*, Warr., l. c., i, p. 367 . . | S.E. Borneo. |
| *Zeuctophlebia rufipalpis*, Warr., l. c., iii, p. 355 . | Queensland. |
| *Callipotnia multicolor*, Warr., l. c., vi, p. 323 . | Dorey. |
| *Physetosteye miranda*, Warr., l. c., iii, p. 99 . . | Humboldt Bay. |

## Family ORTHOSTIXIDÆ.

### Celerena nigripalpis, nov.

♀. Bright chrome yellow, last two joints of the palpi black; fore-wings with the basal half of the costa greyish-purple, ending in a streak downwards to the middle of the interno-median interspace and elbowed outwards within the cell; both wings with a broad greyish-purple border, inwardly margined by a thin purple band.

Expanse of wings 2½ inches.

*Hab.* Pulo Laut, Borneo (*Doherty*).

Akin to *Celerena signata*, Warr., Nov. Zool., v, p. 231, from the Battak Mountains, Sumatra, differing chiefly in the shape and extent of the central streak of the fore-wings; looks like *C. divisa*, Walker, but can at once be differentiated by its black palpi.

### Bytharia marginata.

*Bytharia marginata*, Walker, xxxi, 195 (1864).
*Panathia atrimargo*, Warr., Nov. Zool., iii, p. 298 (1896).
*Xanthomima atrimargo*, Warr., l. c., iv, p. 86 (1897).
*Bytharia latimargo*, Warr., l. c., v, p. 10 (1898).

Type, Batchian ♀ in O. M.
Type (*atrimargo* ♀), Fergusson Isl. in coll. Rothschild.
Type (*latimargo* ♂), Etna Bay, Dutch N. Guinea, in ditto.

*Bytharia marginata* was wrongly identified in the B. M., the species from Sumatra which I have described as *uniformis* and which is very distinct having been mistaken for it.

BYTHARIA LUCIDA.

*Bytharia lucida*, Warr., Nov. Zool., vi, p. 14 (1899).
*Longipalpa circumdata*, Pag., in Chun's Zoologica, 12–29, p. 143 (1900).

Type, N. Hanover in coll. Rothschild.
Type (*circumdata*), Kinigunang (N. Hanover) in coll. Pagenstecher.

Not in B. M.

BYTHARIA UNIFORMIS, nov.

♂. Antennæ black, frons and palpi yellow, top of head slaty mouse colour, body and wings of a uniform pale yellow, costa of fore-wings and outer margin of both wings with pale slaty mouse-coloured bands, much the same colour as the bands of *Celerena divisa*, Walker, from India: the band is about one-fifth of an inch broad on the outer margin, very uniform throughout, slightly wavy on its interior margin, slightly narrower on the costa, turning round below the apex where it is a trifle broader: the underside is like the upperside except that the costal band narrows much towards the base: legs yellow.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab. Sumatra*, four examples.

There is also an example without locality and another marked Java, both received from the E.I.C. Mus., but I doubt the Java locality.

EUMELIA FLAVATA.

*Eumelia flavata*, Moore, Lep. Ceylon, iii, p. 440, pl. 198, f. 3 (1887).
*Eumelia aurigenaria*, Warr., Nov. Zool., vi, p. 15 (1899).

Type, Ceylon in B. M.
Type (*aurigenaria* ♀), Lombok in coll. Rothschild.

Not distinguishable one from the other.

EUMELIA GEMINA.

*Eumelia gemina*, Kirsch, Mitth. Dresden Mus., p. 133, pl. 7, f. 13 (1878).
*Eumelia craspedias*, Meyrick, Trans. Ent. Soc., 1886, p. 156.

Type, N. Guinea in Dresden Mus.
Type (*craspedias*), N. Guinea in B. M.

Genus Holostixa, nov.

Antennæ simple, nearly as long as the costa of fore-wings, palpi upturned reaching vertex of head, second joint hairy, third smooth, nearly as long as second : abdomen slender as long as the hind-wings, legs long, fore-tibiæ covered with double plumes of closely packed hair, hind-tibiæ with very long hairs, fore-wings with the costa nearly straight, outer margin in the male produced into an angle at vein 5, then very oblique, making the hinder margin not more than two-thirds the length of the costa : hind-wings with the costa folded inwards and distorted a little beyond the middle, the fold containing long cilia causing the apex to be very acute and pointed, outer margin slightly rounded ; in the female the outer margin is slightly rounded on both wings, the margin not being produced at vein 5 and the costa of the hind-wings is not distorted : fore-wings with vein 3 some distance before lower angle, 4 from the angle, 5 from a little above centre, 7, 8 and 9 stalked from before upper angle ; hind-wing with vein 3 from before upper angle, 5 from just above middle, bent in the middle in the male, 6 and 7 from before upper angle, veins 7 and 8 terminating in the fold.

Holostixa manca, nov.

♂ ♀. Milky white, fore-wings with the costa rather broadly greyish ochreous, and with a greyish ochreous inner band curving outwardly, from the hinder margin near the base, to the costa near the middle, both wings with a black spot at the end of each cell, a broad greyish ochreous nearly straight band from the abdominal margin one-fourth from anal angle, to the costa of fore-wings one-fifth from apex, a similar but thinner marginal band ; cilia white and glazed ; the long hairs on the hind-tibiæ of the male ochreous.

Expanse of wings ♂ $1\frac{4}{10}$, ♀ $1\frac{7}{10}$ inches.

*Hab.* Baram, Borneo; Matang, Borneo.

Genus Aspilonaxa, Warr., Nov. Zool., iv, p. 386 (1897).

Aspilonaxa obliquaria.

*Naxa obliquaria*, Leech, Ann. Mag. N. H. (6), xix, p. 546 (1897).
*Aspilonaxa lineata*, Warr., l. c., p. 387.

Type, Omeishan in B. M.
Type (*lineata* ♀), Omeishan in coll. Rothschild.

RAMBARA SAPONARIA.

*Zanclopteryx saponaria*, Guen., Phal., ii, 16, 915 (1857).
*Acidalia* (?) *zanclopterata*, Walker, xxvi, 1609 (1862).
*Zanclopteryx fragilis*, Butler, P. Z. S., 1880, p. 687.

Guenée's type came from Ceylon.

Type (*zanclopterata*), Sarawak in O. M.
Type (*fragilis*), Formosa in B. M.

OZOLA MACARIATA.

*Zarmigethusa macariata*, Walker, xxvi, 1637 (1862).
*Macaria elongaria*, Snellen, Tijd. v. Ent., xxiv, p. 86, pl. 10, f. 3 (1881).
*Ozola indefensa*, Warr., Nov. Zool., vi, p. 16 (1899).

Type, Ceram in B. M.
Type (*elongaria*), Celebes in coll. Snellen.
Type (*indefensa* ♂), Dorey in coll. Rothschild.

OZOLA EXIGUA, nov.

♂ ♀. Ochreous grey irrorated with red-brown atoms, fore-wings with an ante-medial outwardly rounded red-brown fine line, a discal line, inclining outwardly and straight to vein 4, then bent inwards and straight to near middle of hinder margin, then down to the margin and carried across the hind-wings, sloping inwards to the abdominal margin before the middle; through this line runs another similarly coloured line, it is quite straight on the fore-wings, but separates from the other line on the hind-wings and ends on the abdominal margin beyond the middle, a brown patch below apex of fore-wings and at apex of hind-wings.

Expanse of wings 1 inch.

*Hab.* CLAREMONT ISL., five males and two females.

Warren in Nov. Zool., vi, p. 17, says with reference to his *Ozola indefensa* that there are examples of it in the B. M. from Claremont Isl., but this is wrong. Warren's *indefensa* cannot be separated from the variable *O. macariata*, Walker, whereas this insect is smaller and differently marked; there is hardly any concavity below apex of fore-wing and the hind-wing is rounded.

Not in B. M.

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|---|---|
| *Celerena cana*, Warr., Nov. Zool., iii, p. 281 | Fergusson Isl. |
| „ *triflava*, Warr., l. c., p. 356 | Biak. |
| „ *signata*, Warr., l. c., v, p. 231 | N.E. Sumatra. |
| „ *aurata*, Warr., l. c., vi, p. 325 | Rossell Isl. |
| „ *exacta*, Warr., l. c. | Solomons. |
| „ *mitis*, Warr., l. c. | Sud Est Isl. |
| *Acratosema subflavata*, Warr., l. c., v, p. 227 | Balabac. |
| *Eumelea albimacula*, Warr., l. c., iv, p. 29 | Obi. |
| „ *unilineata*, Warr., l. c., iv, p. 387 | N. Borneo. |
| „ *degener*, var. *umbrata*, Warr., l. c., iii, p. 356 | Lifu. |
| „ *præusta*, Warr., l. c., iii, p. 358 | Batchian. |
| *Heteralax aspersa*, Warr., l. c., i, p. 369 | Padang. |
| *Derxena discata*, Warr., l. c., iv, p. 206 | Etna Bay. |
| *Rambara colorata*, Warr., l. c., iii, p. 359 | Tenimber. |
| *Noreia albifimbria*, Warr., l. c., iv, p. 206 | Tawaya, north of Palos Bay. |
| *Ozola sinuata*, Warr., l. c., p. 387 | Sumba. |
| *Sebastosema bubonaria*, Warr., l. c., iii, p. 100 | Japan. |
| *Desmobathra plana*, Warr., l. c., p. 380 | Lifu. |

## Family LARENTIIDÆ.

### Docirava pudicata.

*Anaitis pudicata*, Guen., Phal., ii, 497, 1722 (1857).
*Aspilates uvaria*, Walker, xxvi, 1681 (1862).
*Anaitis vastata*, Walker, xxxv, 1700 (1866).
*Docirava affinis*, Warr., Nov. Zool., i, p. 398 (1894).

Guenée's type came from India.

Types (*uvaria* and *vastata*), Darjiling in B. M.
Type (*affinis*), Chang Yang in coll. Rothschild.
There are examples in the B. M. from Sikhim identical with *affinis*.

HYPENORHYNCHUS PALLIDA.

*Tosaura* (?) *pallida*, Warr., Nov. Zool., i, p. 380 (1894).
*Cidaria fasciaria*, Leech, Ann. Mag. N. H. (6), xix, p. 650 (1897).

Type ♀, Japan in coll. Rothschild.
Type (*fasciaria*), Omeishan, W. China, in B. M.

COLLIX HYPOSPILATA.

*Collix hypospilata*, Guen., Phal., ii, 358, 1481 (1857).
*Collix subligata*, Warr., Nov. Zool., iii, p. 385 (1896).

Guenée's type came from Ceylon.

Type (*subligata* ♀), Lifu in coll. Rothschild.

There is an example in the B. M. from Ceylon exactly like Warren's type.

CIDARIA RUBICUNDA, nov.

♀. Head and body reddish-brown, fore-wings ruddy cream colour with two broad reddish-brown bands, the first basal, the second medial, its inner margin angled below the middle, its outer margin angled above the middle, all the margins whitish, a brown apical streak with a whitish spot above it and two whitish spots below it, followed by three brown spots with white centres, the whole forming a submarginal band; hind-wings dull dark red with ochreous costal space; underside pale ochreous tinged with red, fore-wings with the central band pale red-brown; hind-wings with a middle sinuous brown line, edged on its outer side by white spots, both wings with submarginal red-brown band, with a double row of whitish spots on the margin.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* MATANG, Borneo, 3600 feet.

EPIRRHOË OCHRACEARIA.

*Cidaria ochraceata*, Leech, Ann. Mag. N. H. (6), xix, p. 643 (June 1897).
*Euphia propinqua*, Warr., Nov. Zool., iv, p. 234 (August 1897).

Type, Ta-tsien-lu in B. M.
Type (*propinqua* ♂), Pu-tsu-fu in coll. Rothschild.

EPIRRHOË BERTHA, nov.

♂ ♀. Palpi, head and body dark grey-brown speckled with whitish, fore-wings grey irrorated with brown atoms, giving it a steely brown look; a black dot at the end of cell, and transverse chestnut bands; 1st basal, 2nd antemedial even and outwardly curved, between these two bands are indications of another band; 3rd postmedial, broadest with irregular sides; 4th submarginal attenuated hindwards, all the bands with white edges, marginal lunules black; hind-wings dark grey with indications of four transverse thin grey bands, marginal line brown, cilia of both wings brown and white in patches and interlined with brown.

Expanse of wings 1 inch.

*Hab.* HOBART (*J. J. Walker*), five examples.

Allied to *E. scotodes*, Turner.

EPIRRHOË MÆRENS, nov.

♂. Head, thorax and fore-wings greyish-brown tinged with olive, collar whitish, abdomen and hind-wings greyish-white unmarked; fore-wings with five indistinct crenelated transverse lines, sub-basal, antemedial and medial all indistinct; postmedial, curving inwards below the middle then straight down to hinder margin, and submarginal both distinct; marginal line on both wings brown, cilia grey with small white patches.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* MT. KOSINSKO, N.S. Wales.

POLYPHASIA CEPRONA, nov.

♀. Head, thorax and fore-wings brown-pink; fore-wings with three brown ringlets on the costa, a pale pink inner nearly erect band, a discal similarly coloured band from costa at one-third from apex to near outer margin at the middle, where there is a small elongate white spot with a black spot in it, then bending inwards to hinder margin one-third from the angle, marginal line black, cilia brown with white basal line and white patches; hind-wings white, slightly tinged with pink, cilia concolorous, with brown patches; underside, fore-wings brown with a suffused whitish discal band, outwardly angled in the middle, hind-wings same as above.

Expanse of wings $1\frac{3}{10}$ inches.

*Hab.* SUMATRA.

Near *P. cuneifera*, Warr., Nov. Zool., v, p. 29, from Java,

OCHYRIA DISPAR.

*Ochyria dispar*, Warr., Nov. Zool., iv, p. 72 (1897).
*Epirrhoë crepuscularia*, Warr., l. c., p. 234.

Types ♂ ♀, N. Luzon, in coll. Rothschild.
Type (*crepuscularia* ♀), Mindoro in ditto.

XANTHORHOË SEMISIGNATA.

*Larentia semisignata*, Walker, xxiv, 1200 (1862).
*Larentia punctilineata*, Walker, xxiv, 1202.
*Cidaria dissociata*, Walker, xxvi, 1734 (1862).
*Cidaria similisata*, Walker, xxvi, 1735.
*Larentia corcularia*, Guen., Ent. Mo. Mag., v, p. 61 (1868).
*Xanthorhoë farinata*, Warr., Nov. Zool., iii, p. 388 (1896).

Type, N. Zealand in B. M.
Types (*punctilincata*, *dissociata* and *similisata*), N. Zealand in B. M.
Type (*corcularia*), N. Zealand in coll. Oberthur.
Type (*farinata* ♂), N. Zealand in coll. Rothschild.

DASYURIS TRIDENTA, nov.

♀. Head, thorax and fore-wings pinkish-grey; fore-wings with four chestnut-brown elongated marks along the costa, the first two sub-basal and antemedial, with two corresponding brown marks below them, the next two medial and discal, are broad and separated by the subcostal pinkish vein from the broad bands of which they form parts, the medial band is excavated on its inner side, contains a black spot at end of cell, and is margined with white on each side, the discal band forms three large teeth or spear-shaped marks, the upper one subapical and blunt, the other two pointing close to the margin with their bases joined together, and there are some small spear-shaped brown marks on the margin with the points running in on the veins, abdomen and hind-wings dark grey and unmarked.

Expanse of wings 1 inch.

*Hab.* GERALDTON, W. Australia.

GANDARITIS REDUPLICATA.

*Gandaritis reduplicata*, Warr., Nov. Zool., iv, p. 235 (1897).
*Gandaritis flavata*, var. *sinicaria*, Leech, Ann. Mag. N.H. (6), xix, p. 677 (1897).

Type ♀, Omeishan in coll. Rothschild.
Types (*sinicaria* ♂ ♀), Moupin in B. M.

A perfectly good form, quite distinct from *flavata*, Moore, from India, which is not in the B. M. I, however, have *flavata* in my own collection from the Khasia Hills; it has no markings on the hind-wings and is well figured by Hampson at p. 385, vol. iii, Moths of India.

Pomasia conferta, nov.

♂ ♀. Pinkish ochreous, frons head and thorax with olive-brown bands and spots; abdomen with broad brown segmental bands; fore-wings densely packed with six olive-brown bands, all the bands except the one on the outer margin intersected by ochreous lines, all more or less sinuous, the two in the disc more or less outwardly dentated: hind-wings with four bands, the third intersected by a yellow line, the fourth with a row of spots on its outer edge, no marginal band, the bands on the hind-wings much more pronounced in the female than in the male.

Expanse of wings $\frac{8}{10}$ inch.

*Hab.* Pulo Laut (*Doherty*).

Allied to *P. vernacularia*, Guen.

Gymnoscelis subtristigera.

*Eupithecia subtristigera*, Walker, xxxv, 1679 (1866).
*Gymnoscelis perangusta*, Warr., Nov. Zool., iv, p. 229 (1897).

Type, Sarawak in O. M.

Type (*perangusta* ♂), Kuching, Borneo, in coll. Rothschild.

Gymnoscelis biangulata, nov.

♀. Head, body and wings of a uniform pale dull ochreous grey tinged with pink; fore-wings with a brown spot at the end of the cell, some brown irrorations on both wings, a brown discal line angled outwardly twice before the middle on the forewings, again angled below the costa on the hind-wings, otherwise nearly straight; there are also some brownish longitudinal streaks, and brown marginal suffusion, and a whitish submarginal line slightly sinuous on fore-wings, crenelated on hind-wings.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* Sambawa (*Doherty*).

GYMNOSCELIS CONCINNA, nov.

♀. Palpi whitish spotted with black, head, body and wings with the ground colour white, but closely striated and banded with grey, the markings being very evenly disposed ; the fore-wings have also three black bands, 1st from costa before middle abruptly bending inwards on to the hinder margin, and then sub-basally across the hind-wings, the 2nd is beyond the middle running slightly outwards to the centre forming an outer angle, then continued in a row of spots to the hinder margin at the middle, and then across the centre of the hind-wing in a line with two dentations, the 3rd commences near apex in a patch, the continuation on fore-wing poorly indicated, but continued on hind-wing as a well-formed submarginal band ; the outer margin of both wings with large blackish-brown spots.

Expanse of wings $\frac{3}{4}$ inch.

*Hab.* TONGA, two examples.

GYMNOSCELIS MINUTISSIMA, nov.

♂ ♀. Frons and top of head white, body and wings pale ochreous grey tinged with pink ; abdomen with pale segmental bands, wings irrorated with very minute grey atoms, fore-wings with a grey mark at the end of cell, a grey line beyond the middle which is curved outwards below the costa and then straight to the middle of the abdominal margin of the hind-wings, all the outer space on both wings is dark grey caused by what appear to be several grey lines closely packed together, except at the anal angle of hind-wings, where there is a large ochreous white space ; there are some small grey patches or spots on the outer margin, cilia pale grey with dark grey patches and with a pinkish-white basal line.

Expanse of wings $\frac{1}{2}$ inch.

*Hab.* SAMBAWA (*Doherty*).

MARIABA MEDIOPLAGA, nov.

♂. Antennæ palpi and frons ochreous, head, thorax, abdomen and forewings ochreous, very thickly irrorated with brown atoms, these irrorations form broad brown bands on the fore-wings, ante-medial, discal and marginal, and there is a large white space in the middle, extending in the form of a band from the hinder angle to the middle of the wing and then for a short space elbowed inwards ; cilia ochreous, hind-wings ochreous, with a grey double line on the outer margin, which is almost straight, slightly concave, and the wing is produced to a point at the anal angle ; underside ochreous, fore-wings

with a black spot at the end of the cell, followed by a short blackish band and then three other bands, the last on the margin; hind-wings with a central band.

Expanse of wings $\frac{8}{10}$ inch.

*Hab.* Borneo.

Chloroclystis rotundaria, nov.

♀. Frons white, body olive-green, wings dull pale green, a few deep black irrorations scattered all over all the wings, fore-wings with the costa marked with black, brown, and ochreous, along its whole length, apparently indications of transverse bands, but the inner ones are obsolete; there is a black broad band from the costa immediately before the middle and another just beyond the middle, both attenuated hindwards, nearly obsolete before reaching the hinder margin, there is also a black line between them, a broad black subapical band, also attenuated hindwards, its outer edge formed by a white crenelated submarginal line; hind-wings with three black bands, corresponding to the three on the fore-wings, the two first more or less macular, the other submarginal, commencing with a black streak from the costa, outwardly edged by the crenelated white submarginal line, cilia of both wings grey, with ochreous basal spots which interrupt the black marginal line.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* Milne Bay (*A. S. Meek*).

Chloroclystis speciosa, nov.

♀. Pale pinkish-grey, thorax with blackish-brown markings, abdomen with blackish-brown bands on the 2nd, 5th, 6th, and 7th segments; fore-wings with a large brown lunular mark at the end of the cell; some brown costal marks, a brown submarginal line even with the margin, on which there is a brown band, and brown cilia with ochreous spots; hind-wings with four brown lines close together in the middle, and two large brown patches on the margin, one apical and the other at the anal angle, with indications of lines between them, cilia brown.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* Kapaur, N. Guinea (*Doherty*).

Microdes arcuata, nov.

♂ ♀. Frons and top of head nearly white in the male, otherwise the head, thorax and fore-wings are grey, there are three indistinct transverse grey bands, the indications of which are visible on the costa, 1st basal, 2nd antemedial, 3rd medial, the rest of the wing is

marked with white on the veins and has two discal rows of black points, a submarginal row of white marks and white marginal dots interrupting the brown marginal line; hind-wings white without markings.

Expanse of wings ♂ $\frac{8}{10}$, ♀ 1 inch.

*Hab.* S.E. AUSTRALIA (Raynor coll.).

Allied to *M. villosata*, Guen. = *miliaria*, Walker, the costa of fore-wings being similarly arched, but the markings are much more obscure and the large embossed black spot on the hind-wings of the male is wanting.

PHTHONOLOBA IMBECILLA, nov.

♂. Head, thorax and fore-wings dull greenish-grey, fore-wings with two black streaks on the costa, traversed by seven erect but somewhat sinuous dull green bands, the 3rd a mere line, the 4th including a ringlet of dull green, the 5th duplex with two or three outward angles, the 6th composed of spear-shaped marks, the 7th marginal, hind-wings dark grey without markings; abdomen grey with pale segmental thin bands; underside uniform dark grey without any markings.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* KAPAUR, N. Guinea (*Doherty*).

Allied to *P. melanocera*, Hmpsn., from the Nilgiris.

SAURIS HIRUDINATA.

*Collix hirudinata*, Guen., Phal., ii, 362, 1486 (1857).
*Sauris remodesaria*, Walker, xxiv, 1253 (1862).
*Remodes claica*, Meyrick, Trans. Ent. Soc., 1886, p. 193.
*Remodes triseriata*, Moore, Lep. Ceylon, iii, p. 485, pl. 1, f. 4 (1887).
*Remodes interruptata*, Moore, Lep. Atk., p. 270 (1888).
*Remodes cinerosa*, Warr., Nov. Zool., i, p. 397 (1894).
*Remodes angulosa*, Warr., l. c., iii, p. 382 (1896).
*Remodes cirrhigera*, Warr., l. c., iv, p. 395 (1897).

Guenée's type came from Ceylon.

Type (*remodesaria*), Ceylon in B. M.
Type (*claica*), Fiji in coll. Meyrick.
Type (*triseriata*), Ceylon in B. M.
Type (*interruptata*), Darjiling in coll. Staudinger.
Type (*cinerosa*), Nilgiri Hills, in coll. Rothschild.
Type (*angulosa* ♀), Amboina in ditto.
Types (*cirrhigera* ♂ ♀), Woodlark Isl. in ditto.

This variable species is in the B. M. from India, Ceylon, Burma, Sumatra, Fiji, Java, and Australia; Warren's *cirrhigera* is identical with Meyrick's *elaica*.

Sauris infirma, nov.

♀. Frons red-brown, top of head white, thorax and fore-wings greenish-grey, abdomen and hind-wings grey; fore-wings with black streaks along the sub-costal vein, from the base to the middle, nine black marks along the costa, indicating nine transverse black sinuous lines; 1st sub-basal and erect, 2nd obsolescent, 3rd outwardly inclined, 4th obsolescent, 5th and 6th close together and erect, 7th obsolescent, 8th submarginal, duplex in parts and with some small black blotches on it, 9th marginal incomplete, black points on the margin and white interlined cilia; hind-wings without markings; underside ochreous grey without any markings.

Expanse of wings 1 inch.

*Hab.* Pulo Laut (*Doherty*).

Fore-wings shorter and comparatively broader than is usual in the genus.

Sauris nusta, nov.

♂. Head, thorax and fore-wings olive-green; hind-wings blackish-grey, abdomen ochreous grey; fore-wings with four black transverse bands, 1st band composed of five elongated spots, a spot close to the base on its inner side, the 2nd of three dots on subcostal vein a streak below them and a dot near hinder margin, 3rd of three dots on the same vein, under them a broad band narrowing hindwards and intersected by two crenelated pale lines, 4th of one subcostal spot near apex, two above the middle, and one near the end of the 3rd band close to the hinder margin, marginal spots deep black, cilia pale green, whitish in parts; hind-wings without markings; underside dark grey, without markings.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* Milne Bay (*A. S. Meek*).

A well-marked insect.

Eschatarchia lineata.

*Eschatarchia lineata*, Warr., Nov. Zool., i, p. 395 (1894).
*Hydrelia angularia*, Leech, Ann. Mag. N. H. (6), xx, p. 82 (1897).

Type ♂, Japan in coll. Rothschild.
Type (*angularia*), Japan in B. M.

HYDRELIA IMPLETARIA.

*Acidalia impletaria*, Walker, xxxv, 1631 (1866).
*Hydrelia pallidula*, Warr., Nov. Zool., iii, p. 383 (1896).
*Hydrelia subrosea*, Warr., l. c., iv, p. 226 (1897).

Type, Mysol in O. M.
Type (*pallidula* ♀), S. Java, in coll. Rothschild.
Type (*subrosea* ♂), Bali in ditto.

HYDRELIA SANGUINIPLAGA, nov.

♂. Frons white, head and thorax orange-red, abdomen brown, wings white, semi-diaphanous; an orange-red patch at base of fore-wings and a very broad similarly coloured patch at apex; it occupies the outer third of the costa, narrows downwards and ends in a brown streak in the upper disc, with a brown submarginal spot opposite the streak, and a thin brown line from the middle of the streak, to near the hinder margin one-fourth from the angle; a brown dot at the end of each cell in both wings; also a few red minute irrorations; two brown spots at anal angle of hind-wing, outer margin somewhat produced into a short tail at vein four.

Expanse of wings $1\frac{2}{10}$ inches.

*Hab.* PU-TSU-FANG, W. China.

Not in B. M.

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| *Goniopteroloba conjuncta*, Warr., Nov. Zool., iv, p. 230 . . | Mindoro. |
| „ *fuscata*, Warr., l. c., pl. 5, f. 8 | Mindoro. |
| *Carige absorpta*, Warr., l. c., vi, p. 338 . | Japan. |
| „ *combinata*, Warr., l. c., p. 35 . . | S. Flores. |
| *Triphosa moniliferaria ab depleta*, Warr., l. c., p. 42 . . . . . | Ta-tsien-lu. |
| *Cœnocalpe* (?) *legalis*, Warr., l. c., iii, p. 384 | Lifu. |
| *Collix multifiliata*, Warr., l. c., p. 385 . | Cedar Bay. |
| *Ochyria minuta*, Warr., l. c., vi, p. 41 . | Morobo, Bt. N. Guinea. |
| *Propithex alternata*, Warr., l. c., p. 42 . | Ron Isl. |
| *Gonantielea multistriata*, Warr., l. c., iii, p. 386 . . . . . | W. Java. |
| *Xanthorhoë dissociata*, Warr., l. c., iv, p. 74 | Luzon. |
| „ *ab ruptifascia*, Warr., l. c. . | Luzon. |
| „ *ab nigrimedia*,* Warr., l. c. . | Luzon. |
| „ *everetti*, Warr., l. c., . . . | Bonthain. |
| *Perizoma verticata*, Warr., l. c., viii, p. 29 . | W. China. |

* Looks like a distinct species.

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|---|---|
| *Chloroplintha velutina*, Warr., l. c., iv, p. 69 | Bonthain. |
| *Macrulia crassitibia*, Warr., l. c., viii, p. 21 . . . . . | Dammer. |
| *Gymnoscelis grisea*, Warr., l. c., iv, p. 229 . | Fergusson Isl. |
| „ *coquina*, Warr., l. c., p. 69 . | Cedar Bay. |
| „ *pallidirufa*, Warr., l. c., 70 . | Bonthain. |
| *Chloroclystis semivinosa*, Warr., l. c., iii, p. 389. . . . . | E. Java. |
| „ *fragilis*, Warr., l. c., iv, p. 38 . | St. Aignan. |
| „ *infuscata*, Warr., l. c. . . | Baram. |
| „ *minima*, Warr., l. c., p. 227 . | Geraldton. |
| *Rhinoprora regularis*, Warr., l. c., ii, p. 111 | Gunong Ijan. |
| „ *variospila*, Warr., l. c. . . | Gunong Ijan. |
| „ *viridata*, Warr., l. c. . . | Gunong Ijan. |
| *Gymnodisca rubrifusa*, Warr., l. c., p. 109 . | Gunong Ijan. |
| „ *viridescens*, Warr., l. c., p. 110 . | Gunong Ijan. |
| *Megatheca purpurea*, Warr., l. c., p. 230 . | Penang. |
| *Prorocorys gemmata*, Warr., l. c., vi, p. 39 . | Tugela, Solomons. |
| *Tephroclystia fœdatipennis*, Warr., l. c., viii, p. 32 . . . . . | Padang Rengas, Malay Peninsula. |
| *Episteria colligata*, Warr., l. c., vi, p. 36 . | S. Flores. |
| *Opistheploce rufula*, Warr., l. c., p. 340 . | Milne Bay. |
| „ *cinerea*, Warr., l. c., iii, p. 392 . | Batchian. |
| *Tympanota erecta*, Warr., l. c., ii, p. 108 . | Kina Balu. |
| *Holorista margini punctata*, Warr., l. c., vi, p. 339 . . . . . | Negros Philippines. |
| *Holorista usta*, Warr., l. c., ii, p. 106 . . | Gunong Ijan. |
| *Sauris nitidula*, Warr., l. c. . . . | Milne Bay. |
| *Remodes contorta*, Warr., l. c., iv, p. 232 . | Penang. |
| „ *pallidiplaga*, Warr., l. c. . . | E. Java. |
| „ (?) *denigrata*, Warr., l. c., p. 66 . | Perak. |
| „ (?) *rubriplaga*, Warr., l. c., vi, p. 37 | Obi. |
| „ *lobata*, Warr., l. c., ii, p. 107 . | Padang. |
| *Coptogonia turpipennis*, Warr., l. c., iii, p. 381 . . . . | Batchian. |
| „ *lucens*, Warr., l. c., vi, p. 35 . | Woodlark. |
| *Steirophora* aurantisquama*, Warr., l. c., iv, p. 67 . . . . | Java. |
| „ *punctatissima*, Warr., l. c. . | Bonthain. |
| *Helminthoceras sinuaticornis*, Warr., l. c., iii, p. 381 . . . . . | Humboldt Bay. |
| *Cleptocosmia mutabilis*, Warr., l. c., p. 383 | Cedar Bay |

* On the type label *Tympanistes aurantisquama*.

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| *Synneurodes brevipalpis*, Warr., l. c., vi, p. 37 . . . . . | S. Flores. |
| *Camptogramma squamulata*, Warr., l. c., p. 341 . . . . . | Australia. |
| *Bardanes flavata*, Warr., l. c., iii, p. 382 . | W. Java. |
| „ *nigricosta*, Warr., l. c. . . | Humboldt Bay. |
| *Psilocambogia semirubra*, Warr., l. c., p. 384 | Humboldt Bay. |
| „ *undulosaria*, Warr., l. c., iv, p. 227 . . . . | Amboina. |
| *Pseudasthena sordida*, Warr., l. c., p. 223 . | Oinainisa. |
| *Chrysolene* * *dilucida*, Warr., l. c., p. 49 . | Sarawak. |

## Family STERRHIDÆ.

### Craspedia cretata.

*Craspedia cretata*, Warr., Nov. Zool., vii, p. 104 (1900).
*Craspedia undilinea*, Warr., l. c., p. 105.

Type ♂, Sula Mangoli in coll. Rothschild.
Type (*undilinea* ♂), Lifu in ditto.

I can see no specific difference; it is not in the B. M.

### Craspedia adeptaria.

*Acidalia adeptaria*, Walker, xxii, 753 (1861).
*Craspedia* (?) *eximia*, Warr., Nov. Zool., v, p. 18 (1898) (note).

Type, Ceylon in B. M.
Type (*eximia* ♂), Sumba in coll. Rothschild.

### Craspedia strigilaria.

*Geometra strigilaria*, Hübn., Geom., fig. 109 (1803).
*Acidalia subcandidata*, Walker, xxvi, 1607 (1862).
*Craspedia imbella*, Warr., Nov. Zool., viii, p. 22 (1901).

Hübner's type was European.

Type (*subcandidata*), Shanghai in B. M.
Type (*imbella* ♀), Japan in coll. Rothschild.

### Craspedia misera.

*Acidalia misera*, Walker, xxxv, 1630 (1866).
*Craspedia subtincta*, Warren, Nov. Zool., iii. p. 372 (1896).

Type, Flores in O. M.

* On the type label *Anthyria dilucida*.

Types (*subtincta* ♂ ♀), Tenimber Isl. in coll. Rothschild.

The Walkerian type is much faded, but the markings are identical.

Craspedia sybillaria, nov.

♂ ♀. Grey, the ground colour being white covered with very minute grey irrorations, frons black, space between the antennæ white, abdomen with pale segmental bands, wings with a black spot at the end of each cell, fore-wings with an interior line, both wings with medial and discal lines, all the lines grey, sinuous and indistinct, outer marginal space darker grey, containing a submarginal rather prominent whitish sinuous band, marginal lunules black, cilia ochreous grey.

Expanse of wings $\frac{8}{10}$ inch.

*Hab.* Ichang (Mrs. Pratt coll.).

Craspedia suffidaria, nov.

♂. Pure chalky white, bands and markings pinkish-grey, fore-wings with an antemedial line very indistinct, a medial line across both wings, bent in on to the costa of fore-wings, a discal crenelated line curved in to the costa of fore-wings, blackish on the costa and in two little lunular marks in the upper disc, the whole outer space on both wings filled in by two bands of spots or patches, marginal lunular line black, cilia with a grey basal line and in two equal parts, the outer part glistening, a black dot at the end of all the wings; underside pure white, fore-wings suffused with ochreous grey with the discal line only apparent.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* Bali, Low Country (*Doherty*).

Sterrha franconiaria, nov.

♂. Bright pinkish-orange, uniform in colour, frons black, wings with a black dot at the end of each cell, fore-wings with four black marks on the costa, from which four sinuous bands run to the hinder margin, antemedial, medial, discal and submarginal, the first two and last two rather close together, hind-wings with an antemedial band, then three bands close together from middle to margin, all the bands formed by black irrorations, underside pale pinkish-grey without markings.

Expanse of wings $\frac{7}{10}$ inch.

*Hab.* Sherlock River, W. Australia (*Clement*).

STERRHA IOPARIA, nov.

♂. Of a uniform pale greyish-pink, densely irrorated with very minute brown atoms, a lunular brown mark at the end of each cell, two brown linear marks, antemedial with a dot above it indicating a band, and the other below the cell lunule, indicating a medial band; hind-wings with some brown marks indicating a medial band, both wings with two indistinct sinuous lines, discal and submarginal and rather close together, marginal lunules black; underside nearly white with a fine discal and sinuous grey line across both wings.

Expanse of wings 1 inch.

*Hab.* SHERLOCK RIVER, W. Australia (*Clement*).

Genus PTYCHOPODA, Steph., Ill. Brit. Ent., Haust., ii, p. 305 (1829).
JANARDA, Moore, Lep. Atk., p. 265 (1888).
XENOCENTRIS, Meyrick, Trans. Ent. Soc., 1889, p. 484.

PTYCHOPODA RHIPIDURA.

*Xenocentris rhipidura*, Meyrick, l. c.
*Ptychopoda* (?) *sericipennis*, Warr., Nov. Zool., iii, p. 294 (1896).
*Ptychopoda subrubellata*, Warr., l. c., vi, p. 338 (1899).

Type, Port Moresby, N. Guinea, in coll. Meyrick.
Type (*sericipennis* ♀), Fergusson Isl. in coll. Rothschild.
Type (*subrubellata* ♂), N. Guinea in ditto.

PTYCHOPODA CHOTARIA.

*Idæa chotaria*, Swinh., P. Z. S., 1885, p. 858, pl. 57, f. 14.
*Eois lineata*, Hmpsn., Ill. Het., ix, p. 149, pl. 169, f. 10 (1893).
*Ptychopoda pallidivestis*, Warr., Nov. Zool., iii, p. 378 (1896).

Type, Poona in B. M.
Type (*lineata*), Ceylon in B. M.
Type (*pallidivestis* ♂), E. Java in coll. Rothschild.

PTYCHOPODA ACTIOSARIA.

*Acidalia actiosaria*, Walker, xxii, 750 (1861).
*Acidalia renunciata*, Walker, xxiii, 763 (1861).
*Acidalia profanaria*, Walker, xxxv, 1628 (1866).

*Acidalia inficita*, Walker, xxxv, 1630.

Type, Ceylon in B. M.
Type (*renunciata*), Sarawak in O. M.
Type (*profanaria*), South India in B. M.
Type (*inficita*), Flores in O. M.

Genus Ptychophyle, Warr., Nov. Zool., iii, p. 293 (1896).
Chrysolene, Warr., l. c., iv, p. 49 (1897).
Hyria, Steph., Ill. Brit. Ent., Haust., iii, p. 292 (1829 præocc.).

Ptychophyle notata.

*Ptychophyle notata*, Warr., l. c., iii. p. 294.
*Chrysolene insolita*, Warr., l. c., vi, p. 331 (1899).

Type ♂, Fergusson Isl. in coll. Rothschild.
Type (*insolita* ♂), Milne Bay in ditto.

Ptychophyle tristicula.

*Asthena tristicula*, Swinh., P. Z. S., 1885, p. 859, pl. 56, f. 17.
*Ptychophyle tristicula ab fasciata*, Warr., Nov. Zool., vi, p. 33 (1899).
*Ptychophyle læta*, Warr., l. c. p. 337.

Type, Bombay in B. M.
Type (*fasciata* ♂), Goodenough Isl. in coll. Rothschild.
Type (*læta* ♂), Tambora in ditto.

Emmiltis pinguis, nov.

♂ ♀. Of a uniform dark grey, abdomen with very thin segmental pale lines; fore-wings with a black spot at the end of the cell, an antemedial outwardly curved and sinuated black erect line, a discal sinuous black line from hinder margin near the angle to the costa, one-fifth from apex; on the inner side of this line is a broad whitish band, on the outer side the wing is blackish-brown, on the hind wings there is a broad pale discal band, with a blackish indistinct line on each side of it, and the outer margin blackish-brown as in the fore-wings; the underside is paler with most of the markings as above: the female is paler than the male.

Expanse of wings ♂ $\frac{7}{10}$, ♀ $\frac{8}{10}$ inch.

*Hab.* Formosa ♂ (Moore coll.), Chusan ♀ (*J. W. Walker*).

There are also two males from Chekiang and Tonkin.

CHRYSOCRASPEDA LUNULATA, nov.

♂. Frons pure white, head, body and wings of a uniform chestnut-red, indications of a pale discal outwardly curved line across both wings, marginal border of both wings bright ochreous, with the chestnut-red part angled into the yellow, in the centre of the border of both wings, hind-wings with a large pure white lunule at the end of the cell, cilia of both wings bright ochreous yellow; underside body and legs nearly white, wings as above, but pale and dully coloured.

Expanse of wings 1 inch.

*Hab.* SANDAKAN, Borneo.

Of the colour of *C. auricincta*, Hampson, from South India, and much resembling that species, but it can at once be separated by its white frons and the white lunules on the hind-wings.

CHRYSOCRASPEDA SANGUINIPUNCTA, nov.

♀. Head and body crimson, wings bright yellow, fore-wings with costa broadly crimson, caused by crimson irrorations, a few irrorations in the centre of the wing, a ringlet at the end of the cell, thickened irrorations at the base and along the hinder margin, two crimson macular bands discal and submarginal, the largest spot being in the centre of the discal band; hind-wings with a band of spots joined together along the abdominal margin, broadest at the anal angle, almost joining a very broad patch of crimson with a yellow centre at the apex; marginal points of both wings crimson, cilia yellow.

Expanse of wings $\frac{9}{10}$ inch.

*Hab.* KUCHING, Borneo.

CHRYSOCRASPEDA MEDIOPLAGA, nov.

♀. Head and body pinkish-orange, the ground colour of the wings bright yellow, thickly irrorated with scarlet-orange atoms, on all the wings except on the costa of fore-wings; a medial patch which touches the costal band, is excavated outwards above and fines down towards hinder margin and an apical large patch on the outer margin, and on the hind-wing a large basal space, these are all smooth, not irrorated and are of a pinkish-grey colour; the cilia of both wings is yellow, and in the middle of the cilia of the hind-wings is a scarlet-orange spot, there is also a yellow space above medial patch on fore-wings; on the underside the fore-wings are

dull pale pink, with the base and hinder margin yellow, and a yellow patch at end of cell; the hind-wings are yellow, with the basal third, costal space and outer margin dull pale pink.

Expanse of wings 1 inch.

*Hab.* Pulo Laut, Borneo (*Doherty*).

Chrysocraspeda galinaria, nov.

♀. Head and body chocolate, collar and a band on thorax in front yellowish-white and some marks of that colour on head and thorax; fore-wings yellowish-white at base and broadly along costa and apex, the rest of the wing dull chocolate colour, as is also the whole of the hind-wings; on the fore-wings there is a very large brown lunule at the end of the cell and a brown line from it to middle of hinder margin, a pale discal sinuous band, with a brown line running through it, separating the chocolate portion of the wing into two broad bands; hind-wings with an antemedial brown sinuous line, a postmedial sinuous pale band, with a brown line running through it; marginal lunules on both wings brown; underside fore-wings pale rosy-grey, with the cell lunule, and a broad brownish discal band; hind-wings nearly white, also with a discal brownish band, but nearer the margin.

Expanse of wings 1 inch.

*Hab.* Kapaur, New Guinea (*Doherty*).

Chrysocraspeda comptaria, nov.

♂. Head and body chocolate brown, wings rosy, both wings uniform in shade of colour, a chocolate brown band from base of fore-wings runs below the costa, bends round below the apex, is rounded sub-marginally to near the hinder angle, and is continued as a discal band across the hind-wings, the apex and outer margin of fore-wings and the entire outer marginal space of hind-wings is yellow, spotted with chestnut-brown; cilia rosy-grey; underside, rosy slate colour with the outer margin broadly yellowish-white.

Expanse of wings $\frac{8}{10}$ inch.

*Hab.* Singapore (*H. N. Ridley*).

Anisephyra albannularia.

*Thalassodes albannularia*, Walker, xxii, 554 (1861).
*Epione* (?) *invexata*, Walker, xxvi, 1497 (1862).
*Ephyra monochromata*, Walker, xxvi, 1754.
*Ephyra quieta*, Swinhoe, P. Z. S., 1885, p. 856, pl. 56, f. 1.

*Ephyra maculifascia*, Hampson, Ill. Het., viii, p. 111, pl. 151, f. 9 (1891).
*Aniscphyra incorrupta*, Warr., Nov. Zool., iii, p. 370 (1896).
*Anisephyra aurata*, Warr., l. c., iv, p. 47 (1897).

Type, Ceylon in coll. Layard.*
Type (*invexata*), India in O. M.
Type (*monochromata*), India in B. M.
Type (*quieta*), Poona in B. M.
Type (*maculifascia*), Nilgiri Hills in B. M.
Type (*incorrupta*), Dili Timor in coll. Rothschild.
Type (*aurata* ♂), Kalao in ditto.
It is also from Java in the B. M.

PERIXERA OBRINARIA.

*Ephyra obrinaria*, Guen., Phal., i, 414, 675 (1857).
*Anisodes obliviaria*, Walker, xxii, 643 (1861).
*Acidalia contrariata*, Walker, xxiii, 770 (1861).
*Anisodes similaria*, Walker, xxvi, 1582 (1862).
*Anisodes caligata*, Walker, xxvi, 1584.
*Anisodes suspicaria*, Snellen, Tijd. v. Ent., xxiv, p. 80, pl. 8, f. 6 (1881).
*Perixera* (?) *rubrisecta*, Warr., Nov. Zool., v, p. 476 (1898).

Guenée's type came from Ceylon.

Types (*obliviara* and *caligata*), Ceylon in B. M.
Type (*contrariata*), Sarawak in O. M.
Type (*similaria*), Maulmein in B. M.
Type (*suspicaria*), Makassar Celebes in coll. Snellen.
Type (*rubrisecta* ♀), Key Isl. in coll. Rothschild.

PERIXERA HOMOSTOLA.

*Perixera homostola*, Meyrick, Trans. Ent. Soc., 1897, p. 72.
*Brachycola* (?) *inornata*, Warr., Nov. Zool., iv, p. 216 (1897).

Type, Talaut in B. M.
Type (*inornata* ♀), Banda in coll. Rothschild.

PERIXERA AMPLIGUTTA.

*Perixera pallida ab ampligutta*, Warr., Nov. Zool., iii, p. 376 (1896).

Types ♂ ♀, Cedar Bay in coll. Rothschild.

Is I believe a good form and not an aberration; is not in the B. M.

* This collection appears to be lost.

Pisoraca monetaria.

*Anisodes monetaria*, Guen., Phal., i, 418, 683 (1857).
*Pericyra (?) plenilunia*, Warr., Nov. Zool., iv, p. 394 (1897).

Guenée's type came from Borneo.

Type (*plenilunia* ♀), Penang in coll. Rothschild.

Genus Emmesura, Warr., Nov. Zool., v, p. 20 (1898).

Emmesura illepidaria.

*Anisodes illepidaria*, Guen., Phal., i, 421, 693 (1857).
*Anisodes* (?) *semicompleta*, Walker, xxii, 651 (1861).
*Anisodes immemoraria*, Walker, xxxv, 1618 (1866).
*Ainsodes strictaria*, Snellen, Tijd. v. Ent., xxiv, p. 81, pl. 8, f. 7 (1881).
*Anisodes pallida*, Moore, Lep. Ceylon, iii, p. 445, pl. 201, f. 11 (1887).

Guenée's type, a female, came from Sarawak.

Type (*semicompleta* ♀), Sarawak, should be in O. M. but is lost.
Type (*immemoraria* ♂), Java in B. M.
Type (*strictaria* ♂), Celebes in coll. Snellen.
Type (*pallida* ♀), Ceylon in B. M.

*Anisodes contracta*, Walker, xxvi, 1585, the type of which, a female from Sarawak, is in the O. M., I put as a synonym to *Anisodes decretaria*, Walker, in Cat. Het. Mus. Oxon., ii, p. 368, but it is more probably a female of *illepidaria*.

Anisodes ochraria, nov.

♂ ♀. Ochreous fawn colour very uniform in shade, irrorated by dark ochreous atoms, frons white, an ochreous ringlet at the end of each cell, three transverse dark ochreous lines antemedial, medial, and discal, slightly curving outwards all more or less crenelated, the discal line in parts dentated with black dots on the points, a marginal band of a similar nature, all these lines and bands very indistinct in some of the specimens, marginal dots black and the ochreous cilia with some basal black points, underside pale ochreous grey, the inner part of fore-wings suffused with red, an ochreous red crenelated discal line across both wings and black marginal dots.

Expanse of wings $1\frac{4}{10}$ inches.

*Hab.* Singapore (*H. N. Ridley*), one male and two females.

ANISODES GAETA, nov.

♂. Dark ochreous fawn colour, very uniform in shade, densely irrorated with red atoms making it much darker and brighter than *ochracea;* frons white, costa of fore-wings dark brown, a large brown ring at the end of cell of hind-wings filled in with shining white ; both wings crossed by four indistinct ochreous red sinuous lines, antemedial, medial, discal and submarginal, the discal line dentated in parts with red points, marginal points brown very minute, cilia ochreous grey ; underside ochreous white, lines and cell spot fairly distinct and pinkish in colour.

Expanse of wings $1\frac{1}{2}$ inches.

*Hab.* PAKU, Borneo.

Allied to *A. ochracea*, but I think distinct.

GNAMPTOLOMA VIRIDARIA. nov.

♂. Dark sap green, with some white atoms here and there, a small red ringlet with white centre at the end of each cell, a faint indication of the usual transverse line from costa near apex of fore-wings to the middle of the abdominal margin of hind-wings, cilia ochreous grey ; underside ochreous grey covered with green striations, a green discal line and green marginal line ; both wings with the outer margin produced at vein 4, the excavation below the apex of fore-wings very slight.

Expanse of wings $1\frac{2}{16}$ inches.

*Hab.* BALI Low Country (*Doherty*), two examples.

PROBLEPSIS DELPHIARIA.

*Argyris delphiaria*, Guen., Phal., ii, 14, 911 (1857).
*Problepsis vulgaris*, Butler, Ill. Het., viii, p. 43, pl. 125, f. 2 (1889).
*Problepsis auriculifera*, Warr., Nov. Zool., iv, p. 59 (1897).

Guenée's type came from Central India.

Type (*vulgaris*), Kangra in B. M.
Types (*auriculifera* ♂ ♀), Singapore in coll. Rothschild.

Not in B. M.

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| *Craspedia spilodorsata*, Warr., Nov. Zool., ii, p. 93 | | Timor. |
| „ | *æquidistans*, Warr., l. c., iii, p. 371 . | Timor. |
| „ | *nigristellata*, Warr., l. c. . . . | Batchian. |
| „ | *subdecorata*, Warr., l. c. . . . . | N. Borneo. |
| „ | *subtincta*, Warr., l. c., p. 372 . . . | Tenimber. |
| „ | *discata*, Warr., l. c., iv, p. 218 . . | Kiriwini. |

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| *Craspedia pallidilinea*, Warr., l. c., p. 218 | Java. |
| ,, *densicornis*, Warr., l. c., p. 392 | Sumba. |
| ,, *dohertyi*, Warr., l. c., p. 393 | S. Celebes. |
| ,, *colorifica*, Warr., l. c., v, p. 17 | Bali. |
| ,, *coundularia*, Warr., l. c., p. 18 | Sumba. |
| ,, *fumigrisea*, Warr., l. c. | Sumba. |
| ,, *pallidiceps*, Warr., l. c., p. 19 | Lombok. |
| ,, *parumnotata*, Warr., l. c. | Arjuno, Java. |
| ,, *albilarvata*, Warr., l. c., vi, p. 31 | Keeling. |
| ,, *ocellata*, Warr., l. c., p. 333 | Tambora. |
| ,, *nigrocellata*, Warr., l. c., p. 332 | Dammer. |
| ,, *spissitarsata*, Warr., l. c., p. 333 | Luebo Raja. |
| ,, *rufimixtaria*, Warr., l. c., vii, p. 104 | Tenimber Isl. |
| ,, *ignobilis*, Warr., l. c., viii, p. 22 | Japan. |
| ,, *parallelaria*, Warr., l. c., p. 23 | N. China. |
| ,, *crurata*, Warr., l. c., p. 191 | N. Guinea. |
| ,, *exangulata*, Warr., l. c., vi, p. 332 | Milne Bay. |
| *Sterrha* (?) *baptata*, Warr., l. c., iv, p. 224 | Apia. |
| *Ptychopoda rubellata*, Warr., l. c., vi, p. 338 | Milne Bay. |
| ,, (?) *sericeipennis*, Warr., l. c., iii, p. 294 | Fergusson Isl. |
| ,, *deflavata*, Warr., l. c., p. 378 | Tenimber Isl. |
| ,, *pallidivestis*, Warr., l. c. | E. Java. |
| ,, *nigranalis*, Warr., l. c. | Wetter. |
| ,, *squamipunctata*, Warr., l. c., vii, p. 109 | Java. |
| ,, *robusta*, Warr., l. c., p. 108 | Negros. |
| ,, *sextincta*, Warr., l. c. | Penang. |
| ,, *angustipennis*, Warr., l. c., iv, p. 223 | Cedar Bay. |
| ,, *carneola*, Warr., l. c. | Labuan. |
| ,, *carnipes*, Warr., l. c., p. 224 | Cedar Bay. |
| ,, *pilosata*, Warr., l. c., v, p. 21 | Cedar Bay. |
| ,, *sublactifera*, Warr., l. c., vi, p. 337 | Rossell Isl. |
| ,, *scintillans*, Warr., l. c., v, p. 243 | Dawson. |
| ,, *lauta*, Warr., l. c., viii, p. 25 | Japan. |
| *Hemipogon simplex*, Warr., l. c., vi, p. 334 | Sud Est Isl. |
| ,, *nanata*, Warr., l. c., iv, p. 54 | Tenimber Isl. |
| ,, *velutina*, Warr., l. c., p. 55 | Batchian. |
| *Leptomeris alboverticata*, Warr., l. c., ii, p. 96 | Timor. |
| ,, (?) *uniformis*, Warr., l. c., iii, p. 373 | Mackay. |
| *Eois fucosa*, Warr., l. c., vii, p. 106 | Sea Hill. |
| ,, *glabripennis*, Warr., l. c. | Java. |
| ,, *ferrilinea*, Warr., l. c. | Dawson. |
| ,, *carneofasciata*, Warr., l. c., p. 105 | Java. |
| ,, (?) *perspersata*, Warr., l. c., iv, p. 220 | Oinainisa. |
| *Chrysolene flavipuncta*, Warr., l. c., vi, p. 331 | Philippines. |

*Chrysolene cruoraria*, Warr., l. c., iv, p. 49 . . Cedar Bay.
*Ptychophyle inornata*, Warr., l. c., iii, p. 377 . Tenimber Isl.
„ *lineata*, Warr., l. c., p. 378 . . . Dili.
„ *ephyrata*, Warr., l. c., iv, p. 60 . . Tenimber Isl.
„ (?) *pulverulenta*, Warr., l. c. . . . Perak.
*Chrysocraspeda aurimargo*, Warr., l. c., p. 216 . Cedar Bay.
„ *croceomarginata*, Warr., l. c., iii, p. 370 . . . . . Java.
„ *inundata*, Warr., l. c., v, p. 238 . Bt. N. Guinea.
„ *concentrica*, Warr., l. c., vi, p. 30 . St. Aignan.
„ *regalis*, Warr., l. c. . . . . St. Aignan.
*Perixera flavirubra*, Warr., l. c., iii, p. 375 . . Cedar Bay.
„ *venusta*, Warr., l. c., vi, p. 32 . . . St. Aignan.
„ *grisea*, Warr., l. c., p. 336 . . . Ke' Isl.
„ *transversata*, Warr., l. c., iv, p. 58 . . Cedar Bay.
„ *subsimilis*, Warr., l. c., p. 394 . . . S. Celebes.
„ *cretacea*, Warr., l. c., v, p. 20 . . . Woodlark.
„ (?) *flavirubra*, Warr., l. c., iii, p. 375 . . Cedar Bay.
„ *furcata*, Warr., l. c. . . . . Bt. N. Guinea.
„ *roscofusa*, Warr., l. c., p. 376 . . . Mt. Mulu.
„ *multipunctata*, Warr., l. c., vi, p. 336 . N. Guinea.
„ *confiniscripta*, Warr., l. c., iii, p. 374 . Tenimber.
„ sub-sp. *rubripuncta*, Warr., l. c., iv, p. 394 S. Celebes.
„ (?) *radiata*, Warr., l. c., p. 221 . . . Indrulaman.
*Conchocometa sabulosa*, Warr., l. c., ii, p. 91 . . Palawan.
*Pachythalia rotundata*, Warr., l. c., iv, p. 221 . Penang.
*Stiborostoma griseata*, Warr., l. c., iii, p. 380 . . Cedar Bay.
*Pisoraca perumbrata*, Warr., l. c., ii, p. 97 . . S. Celebes.
„ *sordidata*, Warr., l. c., iii, p. 376 . . N. Guinea.
„ *punctata*, Warr., l. c., iv, p. 222 . . Geraldton.
„ *compacta*, Warr., l. c., v, p. 426 . . Key Isl.
*Xenoprora parallela*, Warr., l. c., iv, p. 226 . . Lifu.
*Brachycola niveopuncta*, Warr., l. c., p. 48 . . Cedar Bay.
„ (?) *minorata*, Warr., l. c. . . . . Tenimber Isl.
„ *decolorata*, Warr., l. c., p. 215 . . Lifu.
„ *flavareata*, Warr., l. c. . . . . Penang.
„ *paucinotata*, Warr., l. c., viii, p. 22 . S. Celebes.
*Plocucha cristata*, Warr., l. c., vi, p. 335 . . Solomons.
„ *irregularis*, Warr., l. c., iii, p. 377 . . Humboldt Bay.
*Dizuga sordida*, Warr., l. c., vi, p. 334 . . . Rossell Isl.
*Organopoda olivescens*, Warr., l. c., iii, p. 374 . Cedar Bay.
„ *subbrunnea*, Warr., l. c., iv, p. 393 . S. Celebes.
*Mnesithetis ochrea*, Warr., l. c. . . . . Woodlark Isl.
„ *inobtrusa*, Warr., l. c. . . . . S. Celebes.

*Traminda submarginata*, Warr., l. c., vi, p. 34 . Tambora.
*Symmacra inconspicua*, Warr., l. c., p. 338 . . Milne Bay.
*Erythrolophus bipunctatus*, Warr., l. c., p. 334 . Milne Bay.
*Rhodostrophia inornata*, Warr., l. c., iii, p. 379 . Java.
*Antitrigodes parvimacula*, Warr., l. c., p. 293 . Kiriwini.
*Problepsis hemicyclata*, Warr., l. c., iv, p. 59 . . Kei Tocal.
„ *nugaritata*, Warr., l. c., iii, p. 377 . . Brisbane.
„ *argentea*, Warr., l. c., vii, p. 107 . . Dammer.
„ *craspediata*, Warr., l. c., iv, p. 222 . N. Guinea.
*Problepsiodes argentisquama*, Warr., l. c., vi, p. 337 Penang.
*Somatina rufifascia*, Warr., l. c., iii, p. 379 . . Cedar Bay.
„ *maculata*, Warr., l. c., v, p. 244 . . Coomoo.
„ *sordida*, Warr., l. c. . . . . Dawson.
„ *ossicolor*, Warr., l. c. . . . . Sumba.
*Somatinopsis nigridiscata*, Warr., l. c., iii, p. 379 . Java.
*Nobilia nebulosa*, Warr., l. c., iv, p. 58 . . . Amboina.

## Family GEOMETRIDÆ.

### Pseudoterpna pseudoterpnaria.

*Hypochroma pseudoterpnaria*, Guen., Phal., i, 276, 436 (1857).
*Hypochroma pryeri*, Butler, Ann. Mag. N. H. (5), i, p. 398 (1878).
*Pingasa javensis*, Warr., Nov. Zool., i, p. 383 (1894).

Guenée's type came from North China.

Type (*pryeri*), Japan in B. M.
Type (*javensis*), Java in coll. Rothschild.

I cannot see any difference between them.

### Pseudoterpna deteriorata.

*Hypochroma deteriorata*, Walker, xxi, 441 (1860).
*Hypochroma* (?) *horridata*, Walker, xxvi, 1544 (1862).
*Pseudoterpna horridata*, Swinh., Cat. Het. Mus. Oxon., ii, p. 385, pl. 6, f. 3 (1900).
*Boarmia nigraria*, Feld., Reise Nov., pl. 126, f. 1 (1874).

Type, Australia in B. M.
Type (*horridata* ♀), Sydney in O. M.
Type (*nigraria*), Sydney in coll. Rothschild.

The type specimen of *horridata* by itself looks very distinct, but from the examination of the fine series in the B. M. I am convinced it is only an extremely whitish form of *deteriorata*.

PSEUDOTERPNA QUADRILINEA.

*Hypochroma quadrilinea*, Lucas, Proc. Roy. Soc. Queensland, 1892, p. 80.
*Actenochroma ochrea*, Warr., Nov. Zool., iii, p. 360 (1896).
*Hypochroma ochrea*, Warr., l. c., iv, p. 207 (1897).

Type, Brisbane in coll. Lucas.
Type (*ochrea* ♀), Queensland in coll. Rothschild.

PSEUDOTERPNA SATURATARIA.

*Hypochroma saturataria*, Walker, xxxv, 1593 (1866).
*Pseudoterpna saturataria*, Swinh., Cat. Het. Mus. Oxon., ii, p. 384, pl. 5, f. 6 (1900).
*Hypochroma perfulvata*, Warr., Nov. Zool., vi, p. 326 (1899).

Type, Mysol in O. M.
Type (*perfulvata*), Milne Bay in coll. Rothschild.

DINDICA POLYPHÆNARIA.

*Hypochroma polyphænaria*, Guén., Phal., 289, 446 (1857).
*Hypochroma basiflavata*, Moore, Lep. Atk., p. 248 (1888).
*Dindica marginata*, Warr., Nov. Zool., i, p. 382 (1894).

Guenée's type came from India.

Type (*basiflavata*), Bengal in B. M.
Type (*marginata*), S. Celebes in coll. Rothschild.

There are in the B. M. and in my own collection specimens from Assam absolutely identical with Warren's type, which is merely a common aberration of the species.

ACTENOCHROMA PRASINA.

*Actenochroma* (?) *prasina*, Warr., Nov. Zool., iii, p. 282 (1896).
*Actenochroma ab suffusa*, Warr., l. c., p. 283.
*Actenochroma discolor*, Warr., l. c., p. 359.

Types ♂ ♀ (also the aberration), Fergusson Isl. in coll. Rothschild.
Type (*discolor*), Korrido in ditto.

CHLORODONTOPERA SUAVIS, nov.

♂ ♀. Pale grass green, the female more yellowish and paler than the male : a chestnut-red spot at the end of the cell on each wing, two transverse grey lines on both wings; the first indistinct, one fourth from base, outwardly rounded, the other discal, very sinuous, nearly erect on fore-wings, outwardly curved on hind-wings ; costa of fore-wings chestnut-red dotted with white, outer marginal line of both wings chestnut-red with ochreous grey cilia ; underside paler markings as above.

Expanse of wings ♂ $1\frac{1}{10}$, ♀ $1\frac{2}{10}$ inches.

*Hab.* TENG YENK, Yunnan (*H. E. Hobson*), 4 ♂, 1 ♀; WA-SHAN (*Pratt*), GENSAN (*Pryer*), 3 ♂, 1 ♀.

The Corean examples have turned into a dirty yellow colour but are otherwise identical with those from Yunnan.

AGATHIA PISINA.

*Agathia pisina*, Butler, Ann. Mag. N. H. (5), xx, p. 243 (1887).

*Agathia subcarnea*, Warr., Nov. Zool., iii, p. 285 (1896).

Type ♀, Alu in B. M.

Types (*subcarnea* ♂ ♀), Kiriwini in coll. Rothschild.

AGATHIA VENERANDA, nov.

♂. Head, fore-part of thorax and wings bright emerald-green, the rest of thorax and abdomen of a beautiful purplish-plush colour, fore-wings with the costa purplish-grey, both wings with a basal band and an outer-marginal broad band, purplish-plush colour variegated into many shades, the margins nearly as pale as the costa ; on the fore-wings this band occupies one-third of the wing on the costa, and contains a large oval emerald-green subapical spot ; the inner margin is nearly erect and has a thick dark brown line, and the band narrows to one-fifth from the hinder angle, on the hind-wings the width of the band is more even and it occupies about one-third of the wing and turns up acutely on to the abdominal margin and then narrowly to the base of the wing ; there is a large oval emerald-green spot running on the outer margin, from below the apex nearly to the tail, which is black ; and the thick brown line which inwardly margins the band is outwardly highly dentate ; on the underside the wings are nearly white, no basal band, the outer band purple-pink with no inner marginal thick line and with the green spots nearly white.

Expanse of wings $1\frac{7}{10}$ inches.

*Hab.* KAPAUR, N. Guinea (*Doherty*).

Nearest to *A. hilarata*, Guen.

Uliocnemis cassidaria.

*Phorodesma cassidaria*, Guen., Phal., i, 370, 589 (1857).
*Comibæna biplagiata*, Moore, Lep. Ceylon, iii, p. 435 (1887).
*Uliocnemis elegans*, Warr., Nov. Zool., vi, p. 28 (1899).

Guenée's type came from Central India.

Type (*biplagiata*), Ceylon in B. M.
Type (*elegans*), St. Aignan in coll. Rothschild.

Hemithea ornata.

*Hemithea ornata*, Warr., Nov. Zool., iii, p. 366 (1896).
*Hemithea bella*, Warr., l. c., v, p. 234 (1898).

Type, Adonara in coll. Rothschild.
Type (*bella*), S. Flores in ditto.

I can see no difference : not in B. M.

Hemithea insularia.

*Hemithea insularia*, Guen., Phal., i, 385, 616 (1857).
„ „ Swinh. (nec Hampson), Cat. Het. Mus. Oxon., ii, p. 392 (1900).
*Iodis wuka*, Pag., J. B. Nass. Ver., xxxix, p. 153 (1886).
*Nemoria iosoma*, Meyrick, Trans. Ent. Soc., 1889, p. 495.
*Hemithea pictifimbria*, Warr., Nov. Zool., iii, p. 290 (1896).

Guenée's type came from Borneo.

Type (*wuka*), Ké Island in coll. Pagenstecher.
Type (*iosoma*), Port Moresby in coll. Meyrick.
Type (*pictifimbria*), Fergusson Isl. in coll. Rothschild.

Hemithea vacua, nov.

♂ ♀. Dull dark ochreous, probably green when freshly emerged, a small whitish space on the head between the antennæ, a whitish fairly large but obscure spot at the end of each cell; the outer marginal line slightly darker than the uniform coloration of the wings: no other markings whatsoever either above or below; antennæ of male ciliated.

Expanse of wings ♂ 1, ♀ $1\frac{1}{16}$ inches.

*Hab.* Japan (*Pryer*).

Metallochlora militaris.

*Iodis militaris*, Lucas, Proc. Linn. Soc., N.S.W., 1891, p. 295.
„ „ Warr., Nov. Zool., v, p. 432 (1898).
*Metallochlora dotata*, Warr., l. c., iii, p. 367 (1896).
*Metallochlora flavifimbria*, Warr., l. c.

Type, Brisbane in coll. Lucas.
Types (*dotata* ♂ ♀), Queensland in coll. Rothschild.
Type (*flavifimbria* ♂), Cairns in ditto.

Not in B. M.

Lophocrita undifera.

*Thalera undifera*, Walker, xxii, 601 (1861).
*Lophocrita undifera*, Swinh., Cat. Het. Mus. Oxon., ii, p. 393, pl. 6, f. 10 (1900).
*Hemithea subflavida*, Warr., Nov. Zool., iii, p. 290 (1896).
*Hemithea (sub-sp.) reducta*, Warr., l. c., iii, p. 367.

Type, Sarawak in O. M.
Type (*subflavida* ♂), Fergusson Isl. in coll. Rothschild.
Types (*reducta* ♂ ♀), Humboldt Bay in ditto.

Probolosceles mariæ.

*Iodis mariæ*, Lucas, Proc. Linn. Soc., N.S.W., 1888, p. 1266.
*Probolosceles albipunctata*, Warr., Nov. Zool., v, p. 15 (1898).
*Probolosceles connecta*, Warr., l. c.

Type, New South Wales in coll. Lucas.
Types (*albipunctata* ♂ ♀), Brisbane in coll. Rothschild.
Type (*connecta* ♂), Dawson, Queensland in ditto.

The last two only vary in the size of the spots: the species is not in the B. M.

Genus Comostolodes, Warr., Nov. Zool., iii, p. 308 (1896).

Comostolodes inductaria.

*Comibæna inductaria*, Guen., Phal., i, 370, 588 (1857).
*Comostolodes inductaria*, Warr., Nov. Zool., vi, p. 22 (1899).
*Eucrostis smaragdus*, Hmpsn., Ill. Het., viii, p. 110, pl. 151, f. 15 (1891).

*Comostolodes consobrina*, Warr., Nov. Zool., iv, p. 210 (1897).

Guenée's type came from Sarawak.

Type (*smaragdus*), Nilgiri Hills in B. M.
Types (*consobrina* ♂ ♀), Cedar Bay in coll. Rothschild.

Warren's note in Nov. Zool., vi, p. 22, seems to be unanswerable; it is a pity we cannot get Guenée's types for examination, and if ever they do come to London I imagine they will upset several species, because I feel certain many of them have not been properly identified. I cannot see any difference between *smaragdus* and *consobrina*.

Genus Thalassodes, Guen., Phal., i, p. 359 (1857).
Prasinosima, Warr., Nov. Zool., iv, p. 44 (1897).

Thalassodes rufitincta.

*Prasinosima rufitincta*, Warr., l. c.
*Thalassodes flavicosta*, Warr., l. c., p. 214.

Types ♂ ♀, Lifu, in coll. Rothschild.
Type (*flavicosta* ♂), Port Darwin in ditto.

I can see no difference, except that the hind-wings of *flavicosta* are slightly inclined to be angled in the middle of outer margin, and this is not perceptible in *rufitincta*, but is commonly so in this Genus.

Thalassodes curiosa, nov.

♂. Frons and space between antennæ white, antennæ grey, body and wings dark green, of a darker and duller colour than is usual in the genus, fore-wings with the costal line ochreous grey, both wings with very indistinct transverse more or less dentate bands, interior and exterior very difficult to follow, the interior band appears to be erect, the exterior band is very dentate, outwardly on fore-wings and on the hind-wings forms an acute angle towards the outer margin below the middle, and then runs into the abdominal margin a third from the anal angle; on the underside the palpi, body and legs are white, the wings pale greenish-grey, costa of fore-wings ochreous; otherwise unmarked.

Expanse of wings 1½ inches.

*Hab.* Penang (*S. S. Flower*).

It somewhat resembles *T. saturata*, Snellen, from Celebes, Tijd. v. Ent., xxiv, p. 77, pl. 8, f. 3 (1881).

ŒNOSPILA FLAVIFUSCATA.

*Thalera flavifuscata*, Walker, xxii, 596 (1861).
*Œnospila flavifuscata*, Swinh., Cat. Het. Mus. Oxon., ii, p. 400 (1900).
*Œnospila flavilinea*, Warr., Nov. Zool., iv, p. 212 (1897).
*Gelasma* (?) *perlineata*, Warr., l. c., vi, p. 330 (1899).

Type, Ceylon in B. M.
Type (*flavilinea* ♂), Cedar Bay in coll. Rothschild.
Type (*perlineata* ♀), Tugela, Solomon Isls., in ditto.

I can see no specific difference between these types.

ŒNOSPILA STRIX.

*Racheospila strix*, Butl., Ill. Het., vii, p. 105, pl. 136, f. 8 (1889).
*Œnospila stellata*, Warr., Nov. Zool., iii, p. 292 (1896).

Type, Dharmsala in B. M.
Type (*stellata*), Fergusson Isl. in coll. Rothschild.

Though the two localities are very far apart, I cannot distinguish any specific difference between the two type specimens.

GELASMA FLAGELLARIA.

*Hemithea flagellaria*, Pouj., Ann. Soc. Ent. Fr., 1895, p. 310, pl. 6, f. 8.
*Gelasma albistrigata*, Warr., Nov. Zool., ii, p. 89 (1895).

Type, Moupin in coll. Poujard.
Type (*albistrigata*), Japan in coll. Rothschild.

GELASMA OPALARIA.

*Iodis opalaria*, Guen., Phal., i, 357, 558 (1857).
*Thalassodes opalaria*, Hmpsn., Moths, iii, p. 509 (1895).
*Thalera subtractata*, Walker, xxvi, 1753 (1862).
*Iodis spumifera*, Warr., Nov. Zool., v, p. 235 (1898).

Guenée's type came from Central India.

Type (*subtractata*), Maulmein in B. M.
Type (*spumifera* ♂), Penang in coll. Rothschild.

The type specimens of the last two are identical.

GELASMA AMBIGUA.

*Thalassodes ambigua*, Butl., Ill. Het., ii, p. 49, pl. 36, f. 6 (1878).

*Iodis dentifascia*, Warr., Nov. Zool., iv, p. 212 (1897).

Type, Japan in B. M.
Type (*dentifascia*), Japan in coll. Rothschild.

GELASMA RUFIMARGO.

*Chloromachia divapala* var. *rufimargo*, Warr., Nov. Zool., iv, p. 209 (1897).

Type, Penangah in coll. Rothschild.

This looks to me like a good species and not a variety.

ORNITHOSPILA RUBRITINCTA.

*Chrysochloroma subalbida ab rubritincta*, Warr., Nov. Zool., iii, p. 364 (1896).
Type, Humboldt Bay in coll. Rothschild.
In my opinion, a good species and quite distinct from the Australian form *subalbida*. Not in B. M.

BERTA DISCOLOR.

*Berta* (?) *discolor*, Warr., Nov. Zool., i, p. 389 (1894).
*Berta olivescens*, Warr., l. c., iii., p. 287 (1896).

Type ♂, Padang in coll. Rothschild.
Type (*olivescens* ♂), Fergusson Isl. in ditto.

Not in B. M.

| | | |
|---|---|---|
| *Hypochroma* | *subrubescens*, Warr., Nov. Zool., iii, p. 102 . . | Mackay. |
| ,, | *subornata*, Warr., l. c., p. 360 . | Cedar Bay. |
| ,, | *vividicoma*, Warr., l. c., vi, p. 18 | Solomons. |
| ,, | *multicolor*, Warr., l. c., p. 17 . | St. Aignan. |
| *Pingasa angulifera*, Warr., l. c., iii, p. 283 . | | Fergusson Isl. |
| ,, | *cinerea*, Warr., l. c., i, p. 382 . | Australia. |
| ,, | *atriscripta*, Warr., l. c., vi, p. 19 . | Goodenough Isl. |
| *Actenochroma languida*, Warr., l. c., v, p. 232 | | N. Guinea. |
| ,, | *unicolor*, Warr., l. c., vi, p. 17 | Mt. Dulit. |
| ,, | *cæsia*, Warr., l. c., iii, p. 282 | Fergusson Isl. |
| ,, | *flavibasis*, Warr., l. c., i, p. 381 . . . . . | Java. |
| *Terpna crassistriga*, Warr., l. c., iii, p. 361 . | | Natuna Isl. |
| ,, | *ruficoloraria*, Warr., l. c., iv, p. 32 . | Kina Balu. |
| ,, | *tenuilinea*, Warr., l. c., vi, p. 19 . | Tambora. |
| *Euxena insulata*, Warr., l. c., iv, p. 39. . | | Luzon. |

*Chlorodontopera albigutta*, Warr., l. c., i, p. 387 . . . . . Padang.
*Chloromachia* (?) *pallidata*, Warr., l. c., vi, p. 329 . . . . . Milne Bay.
*Episothalma subaurata*, Warr., l. c., p. 399 Milne Bay.
*Halterophora bicolor*, Warr., l. c., iii, p. 290 Fergusson Isl.
„ *fulgurata*, Warr., l. c., iv, p. 39 Moroka, Bt. N. Guinea.
*Agathia cinerea*, Warr., l. c., iii, p. 284 . Fergusson Isl.
„ *succedanea*, Warr., l. c., iv, p. 388 . Kina Balu.
„ *kuhni*, Warr., l. c., v, p. 425 . . Key Isl.
„ *exquisita*, Warr., l. c., vi, p. 20 . Obi.
„ *punctata*, Warr., l. c., p. 327 . Dammer.
„ *disconnecta*, Warr., l. c., iii, p. 362 Cairns.
„ *rubilineata*, Warr., l. c. . . N. Borneo.
*Agathiopsis basipuncta*, Warr., l. c., iii, p. 285 Fergusson Isl.
*Uliocnemis pulchella*, Warr., l. c., vi, p. 28. Ron. Isl.
„ *woodfordi*, Warr., l. c., p. 29 . Solomons.
*Chlorostrota discata*, Warr., l. c., iv, p. 389 Kina Balu.
*Chrysomphe venusta*, Warr., l. c., iii, p. 365 Cedar Bay.
*Hemithea quadripunctata*, Warr., l. c., p. 367 . . . . . Oinainisa.
**Diplodesma olivata*, Warr., l. c., iv, p. 389 Sandakan.
*Tanaorhinus unipuncta*, Warr., l. c., vi, p. 331 . . . . . Milne Bay.
*Mixochlora alternata*, Warr., l. c., iv, p. 42 Luzon.
*Euchloris* (?) *viridifrons*, Warr., l. c., p. 389 Amu Darja.
*Anisogamia subliturata*, Warr., l. c., vi, p. 327 . . . . . Milne Bay.
„ *absona*, Warr., l. c., iii, p. 287 . Kiriwini.
„ *dentata*, Warr., l. c., iv, p. 34 . Cedar Bay.
„ † *albimacula*, Warr., l. c., p. 33 . Mackay.
„ † *curvigutta*, Warr., l. c., p. 34 . Mackay.
„ † *muscosa*, Warr., l. c., p. 35 . Fergusson Isl.
‡ „ *albilauta*, Warr., l. c., p. 33 . N. Guinea.
§ „ *nigrimaculata*, Warr., l. c., p. 35 . . . . . N. Guinea.
*Chlorochroma* (?) *marginata*, Warr., l. c., vi, p. 21 . . . . . Little Kei.

* *Holophanes* on type label.

† *Hemalolepis* on type labels and on the *muscosa* type label is N. Guinea.

‡ *Chloroteras* on type label.

§ *Chrysochloroma* on type label.

| | |
|---|---|
| *Helicopage velata*, Warr., l. c., iv, p. 390 . | Woodlark Isl. |
| *Probolosceles pallidicincta*, Warr., l. c., p. 213 | Java. |
| * *Cosmogonia decorata*, Warr., l. c., iii, p. 369. . . . . | Cedar Bay. |
| *Metallochlora meeki*, Warr., l. c., iii, p. 291 | Fergusson Isl. |
| „ *lineata*, Warr., l. c. . . | Kiriwini. |
| „ *termilinea*, Warr., l. c., p. 368 | Milne Bay. |
| „ *sanguinipuncta*, Warr., l. c., v, p. 425 . . . . | Kei. |
| „ *proximata*, Warr., l. c., vi, p. 26 . . . . . | Solomons. |
| *Thalassodes gigas*, Warr., l. c., p. 28 . . | Solomons. |
| „ *albifusa*, Warr., l. c., iii, p. 293 | Fergusson Isl. |
| „ *viridicaput*, Warr., l. c., iv, p. 391 . . . . . | S. Celebes. |
| *Prasinocyma absimilis*, Warr., l. c., viii, p. 193 . . . . . | Etna Bay. |
| *Œnospila lucifimbriata*, Warr., l. c., vi, p. 27 | Solomons. |
| „ (?) *simplex*, Warr., l. c., p. 330 . | Java. |
| *Colutoceras diluta*, Warr., l. c., ii, p. 88 . | Japan. |
| *Pyrrhorachis cornuta*, Warr., l. c., iii, p. 292 | Fergusson Isl. |
| *Oxychora tenuis*, Warr., l. c., v, p. 236 . | Bouru. |
| *Cenochlora felix*, Warr., l. c., p. 12 . . | Dawson. |
| *Agraptochlora marginata*, Warr., l. c., i, p. 390 . . . . . | Japan. |
| *Gelasma sublustris*, Warr., l. c., vi, p. 24 . | Ron. Isl. |
| „ *unicolor*, Warr., l. c. . . . | S. Flores. |
| „ **cynthia*, Warr., l. c., p. 23. . . | Woodford Isl. |
| *Crysochloroma meeki*, Warr., l. c., iii, p. 288 | Fergusson Isl. |
| „ *electrica*, Warr., l. c., p. 363 . | Humboldt Bay. |
| *Iodis micra*, Warr., l. c., iv, p. 212 . . | Bali. |
| „ *viridaurea*, Walk., l. c., vi, p. 25 . | Ron. Isl. |

* *Thalerura* on type labels.

# XIX. *On asymmetry in the Males of* Hemarine *and other Sphinges.*

By Thomas Algernon Chapman, M.D., F.Z.S.

[Read May 7th, 1902.]

Plates XXIV. and XXV.

A want of bilateral symmetry in insects has been recorded of a great many different species and groups, in many different orders. In the Lepidoptera, however, the recorded instances are few, practically the only well-known instance is in the genus *Thanaos* of Hesperid butterflies; I am indebted to Dr. Sharp for references to instances occurring also in *Butalidæ*, *Pterophoridæ*, and *Psychidæ*, recorded in a paper by Poljanec in Arb. Inst., Wien, xiii, 1901, pp. 155—196, and he informs me that minor instances affect certain *Noctuidæ*.

In the *Sphinges* it affects the whole family, probably affects every species, though there are certainly a good many in which, if present, it is reduced to so evanescent a degree that I have not detected it.

When asymmetry occurs in insects, it affects the sexual appendages in a great majority of recorded instances, this is so in all the cases of Lepidoptera I have just referred to, and is also the case in the Sphinges.

Gosse in his paper in the Linnæan Trans., mentions that the *Ædœagus* of *Papilio memnon* is curved towards the right side, and he implies vaguely a similar condition in one or two other species.

Except in the *Hemarids*, the asymmetry in *Sphinges* affects only the *ædœagus* in any species I have examined, and does so in many curious forms. In the Hemarines (clearwings) it has gone further and affects the harpes, the valves, and even the tegumen.

My object in this paper is merely to call attention to the facts from a morphological point of view, without attempting any systematic applications, beyond stating my belief that a classification and revision of the Sphinges on the characters of the male genitalia alone would give us better results than any we now have, and that these azygos

developments would no doubt prove to afford an important part of the data.

Why asymmetry of the central organ should be so common in the group and not have passed to the other parts except in the one minor subfamily of *Hemarinæ* I do not know, it is not impossible that it has in fact done so, in cases of which I have no knowledge.

I cannot help thinking that in the LEPIDOPTERA asymmetry of the *ædeagus* is probably really very much more frequent than we imagine. Unless exceedingly pronounced, the two commonest ways of mounting the appendages for examination would probably lead to its being entirely overlooked. One is to mount the parts on a glass slide, the other to separate the parts and mount each separately on a card or mica slip. In either of these ways the precise orientation of the *ædeagus* would be very likely, if not certain, to be lost, and the opening really existing on the right side of the tube would be believed to be below, and any azygos appendage of the left side would be assumed to be dorsal (or possibly ventral). The Sphinges are so large that there is no difficulty in preserving the specimens in their natural positions (approximately), and examining them so. Even in *Papilio*, however, in which Gosse apparently followed this plan, he appears to have met with some unilateral deviations, which he explained away as merely apparent and probably due to rotation of the tube on its axis.

In the *Hemarinæ*, where the asymmetry affects the valves, and more especially their inner spines (harpes), the nature of the asymmetry is different from that obtaining in the genus *Thanaos*. In the first place Scudder makes no mention of the *ædeagus*, which one assumes therefore to be symmetrical. The remarkable differences in the valves of the two sides, strike one as being complementary. The work to be done on either side is precisely the same as that on the other, and neither valve is definitely larger or smaller, more twisted one way or other, than the other one. The object would appear to be, not only to do its own work better, but to assist the valve of the other side in doing the same, just as in the much simpler apparatus of a catch forceps, the teeth on the two sides differ, not to perform different functions, but really identical functions more efficiently.

In *Hemaris*, the two sides differ by actual diminution

of size and complexity affecting one side without very great change in the other; and in addition to this the diminishing side appears to retain or increase its range of movement, the larger side, by comparison at any rate, losing it. The arrangements would seem to imply that in pairing, approach is made laterally and not vertically, and that to admit of this occurring more readily one side becomes smaller and more movable.

A similar change, apparently for a similar reason, is, I believe, not infrequent in COLEOPTERA, perhaps it is only ignorance that leads us to believe it rare in Lepidoptera. Since it is, I think I may say, the rule, in Lepidoptera for the insects to approach each other laterally, although the mobility of the abdominal segments prevents this affecting the actual pairing organs. It is, also, probable that the approach is as often made from one side as from the other, but on this point I have neither made nor heard of any observations, beyond knowing that I have often, but in what species I do not remember, seen the male endeavouring to reach the female, first from one side, then from the other, perhaps several times, before succeeding in his endeavours.

Still less can I guess as to the conditions obtaining in this aspect, in the nearly allied family of the *Trichoptera*, in which Mr. McLachlan records some striking instances of asymmetry in the whole genus *Glossosoma* (European Trichoptera, p. 468), as well as in *Letodes interrupta* (p. 340) and *Leptocerus inaequalis* (First additional supplement, p. 34), in all cases with figures.

To give any general description of the asymmetry of the *ædœagus* as it occurs throughout the whole family of Sphingides is practically impossible, so many different forms does it assume.

It is reduced to vanishing point in *A. convolvuli*, *M. atropos*, *Sp. ligustri*, and *Ambulyx rostralis*, where the tube is cylindrical and the opening terminal. In *Mimas tiliæ* and *A. populi* it appears to be actually or very nearly symmetrical, but there is a great difference in the armature of great spines on the eversible membrane (true *penis*), between the two sides. In *Sm. ocellatus* there is a great bluntly-pointed projection on the left margin of the terminal opening. It is rather rare to have this eversible membrane in evidence, so that its peculiarities remain easily unobserved, but except in some Amorphids I have not observed it armed in any way.

In Macroglossa the tube is very short and wide; besides less easily described irregularities, it carries a curved spine, arising on the right side and curving over the dorsum, parallel to the margin. *Rhopalopsyche* and *Rhodosoma* are not very dissimilar, *Enyo*, *Salaspes*, and *Acllopus* incline rather to follow the pattern of *Hemaris*, in which the *ædœagus* is extremely slender and rather long, and has a spine, continuing the line of the tube from its left margin, so that the tube appears to taper to a point and to have the opening on the right side, just where the tapering commences. The difficulty of grounding ideas of relationship on similarity of these structures is illustrated by the very similar structure in *Sphinx pinastri*, where the tube is long and very slender and ends in a similar point to that in *Hemaris*, it is however on the right side and has two subsidiary processes beside or opposite to it.

In *Deilephila* (*Euphorbiæ*, *galii*, *lineata*) there is a curious valvular arrangement, in connection with a strong armed ridge running down the right margin.

In the genus *Hemaris* the slenderness of the *ædœagus* makes it easy to overlook its asymmetrical character, but here the harpes and valves have become involved.

In *Sphinges* (broadly) the valves are wide and large and free from any special developments, basally and ventrally however there are, when present, the harpes, consisting on each valve of a rather swollen base which carries a process, that lies just within the margin of the valve, sometimes a thick baton, a short or a very long slender hook more or less curved, etc.; and nearer the centre of the valve another usually conical process or spine. The latter is very usually absent, it is apparently, hardly, if at all, represented in *Hemaris*. It possesses, however, the first process as a straight baton somewhat bulbous at the end, or at least one supposes the original Hemaris with the parts symmetrical did so. The first step in asymmetry is for this process to disappear on the left side, it tended next to disappear on the right also, but meantime the left valve became emarginate, and so in *Hemaris* there are varying degrees of loss of the batons and emargination of the valves, always far advanced on the left side.

In *Cephonodes*, the batons are entirely gone, and a great emargination of the left valve occurs. In the Indian *Hylas* the two cusps at the margins of the left valve are much alike in structure. An apparently identical insect, from I

imagine Africa, has the upper cusp with somewhat reduced neck and rounded spinous head.

To return to *Hemaris*, in *Bombyliformis* (*tityus, scabiosæ*) the emargination of the valve requires careful comparison with the opposite valve in order to feel sure of it, the baton of the harpe is well developed on the right side, represented by the minute elevation on the other. *Croatica*, which looks as if closely allied to *Fuciformis*, has the appendages very nearly identical with those of *Bombyliformis*. In *Fuciformis*, the baton of the left harpe is a slight projection, the right one is very small, but apparently of the same structure as in *Bombyliformis*.

In *Thysbe*, the form of the right baton differs a little from that of *Bombyliformis* but it is fully as large, whilst the left one is represented by a very small thimble-shaped process. The emargination of the left valve is marked. *H. diffinis* again has a somewhat different form of baton, but the left is of exceedingly reduced proportions, although the valves seem to be symmetrical. There is some indication of the tegumen being twisted; this is very marked in *Cephonodes*, where even its base on one side differs from the other.

In *Cephonodes hylas* (India), the *ædœagus* is very long and very slender, the terminal spine has all the appearance of being a continuation of the shaft gradually diminishing to a point, with the opening a short way from the extremity and on the right side. The right clasp is large, salver-shaped, somewhat imperfectly articulated at the base, so that its range of movement is very restricted. The left clasp is much smaller, in form as if it had had the same outline as the right, but had had a large terminal disc excised, leaving an upper, narrower longer, and lower shorter and broader cusp. It is shorter than the right, as about 3—5, if its emarginate outline allows a length to be given it. The arrangement of bristles, etc., differs from that on the right side. It is much more movable on its articulation than the right one. The articulation seems incomplete in all these Hemarids, *i. e.* the connecting, articulating membrane is not mere membrane, but is fairly chitinized, and does not, for instance, tear readily for disarticulation. The great gap in the left clasp is clearly homologous to the emargination in that of *Hemaris*. This is on the lower margin in *Hemaris*, but the portion below it has here become more extended,

that above (the main part of the valve in *Hemaris*) so diminished that the emargination is now terminal and not ventral.

The tegumen is also affected, its right swollen base is much larger than the left (as seen from above), largely owing to its being horizontal in position and that on the left more vertical, but there is an actual difference; beyond this is a laterally flattened shaft, which twists, so as to throw the upper edge of the end right over to the left side, and so the descending hook-like process below this bends over very much to the right. There is no subanal process.

In *Hemaris* the tegumen seems to be unaffected.

*Hemaris bombyliformis* (*scabiosæ*, *tityus*).—The differences between the two sides here are marked, and affect several portions of the appendages. The *vdvaqus*, which is here extremely long and extremely slender, perhaps 6 m.m. in length, if separated, has the hook or flange developed into a straight spine nearly ·7 m.m. in length, and looking like a continuation of the shaft of the *vdvaqus*. It does, however, bend a little upwards and to the left, so that the opening faces a little to the right and downwards.

There is a membranous (double) sheath to the *vdvaqus*, which has much the same size and aspect as the sheath in some others (*Proserpina*, *Idricus*, *Sataspes*, etc.): it seems larger and fuller on the right side, but in soft parts softened, one cannot depend much on this being the natural aspect.

The double upper piece (tegumen) seems to be quite symmetrical, but the side pieces (valve and harpe) are quite different on the two sides, at least the lower spinous portion (harpe) is so, very markedly. When the valves are separated, the most ventral portion of each, where they meet in the middle line, presents an inflated, ovoid piece, a piece of about 1 m.m. in length. On the left side this piece carries at its summit a series of dark, short, spine-like bristles, on the right side it is produced into a cylindrical process a full m.m. long, and ending in a rounded slightly bulbous end, clothed with similar bristles to those sessilely placed on the other side. It is not very clear whether there is any sort of articulation between this (harpe ?) and the long spatula-like valve proper. The left valve may be described as being deeply notched opposite

the wanting process of the harpe, but perhaps more correctly as having a short expansion below this quite at its base.

The *ædœagus* itself when extended is directed somewhat to the right side; so that we have in a plane, passing from below upwards, from the right side to the left and obliquely, so that it would in front be to the left, firstly, the long harpe of the right side, then the longest portion of the sheath, then the opening of the *ædœagus*, and then the shaft of the *ædœagus*, with the terminal spine directed straight backwards, the oblique position of the *ædœagus* just equalling the bend at the orifice made by the spine.

*Hemaris croatica* has the *ædœagus* almost identical with that described under *bombyliformis*. The lower (harpe) portion of the valve carries, as in *bombyliformis*, only on the right side a long process with round curved shaft and bulbous extremity, represented on the left side by only a few bristles; the large flat portion of valve has on the left side a deep sinuation or notch, opposite the place where the lower piece is, on this side, wanting.

*H. diffinis*.—Of two prepared specimens of this, the tegumen in both is twisted to the left. I have not noticed this definitely elsewhere. I am not prepared, however, to feel sure that the appearance is not artificial, due to the greater mobility of one clasp, twisting the basal ring, when both are forced equally apart. The opening of the sheath is definitely on the left, *i. e.* its prolonged apex is to the right. The *ædœagus* is very like that of the other Hemarids, slender, with opening to right and a point beyond directed to the left; this point is very little, if anything, beyond the prolonged opening of the *ædœagus*. The basal bulla of the clasp is more specialized, having a very definite process near its distal extremity, projecting inwards, rounded and very finely spiculated. On the right side is the usual prolongation, rather longer than usual and much more slender; on the left side it is represented by an extremely short rounded process. Both these processes are united basally to the flat portion of the valve, as does not occur in the other species examined, and the valves themselves are broad without emargination, and not very definitely asymmetrical in any way, except in the union with the harpe processes.

In *Fuciformis* the asymmetry would almost escape

notice unless looked for. There is a well-developed symmetrical sheath, the *ædœagus* itself is very long and very slender, as in *bombyliformis*, but though the opening is to the right side the process beyond it is short and blunt, at least viewed laterally, viewed dorsally it seems very sharp; in reality, it is merely the lip of the terminal opening, prolonged on the left side. The ventral basal inflations of the valves are much the same on both sides; the left one terminates in a rather sharp angle, with some bristles, the right in a process like that of *bombyliformis* and *croatica*, but by comparison ridiculously minute, so as to be easily overlooked. The flat portion of the valve is deeply emarginate on both sides, so as to present a long slender strip, with a basal projection (the piece below the emargination) on the ventral side. This basal projection is much narrower on the left side.

*H. thysbe* has a sheath symmetrical and even more fully developed than in *fuciformis*. The *ædœagus* is a little more robust, has the opening to right side and a spine continued a little beyond it, with a little flexure to the left. The basal bulla of the clasps is larger on the right side, and has the terminal process on that side well developed, much for size as in *bombyliformis*, but straighter, with a more slender shaft and more globular head, armed with quite long bristles on its dorsal side. On the left side, the smaller bulla terminates in a short thimble-shaped process, not $\frac{1}{3}$ as long as that on the other side; it carries a few bristles. On the right side the flat process of the valve diminishes in width from about its middle. On the left side, it begins to diminish close to the base, and the valve is very narrow about $\frac{2}{5}$ from the base and gets a little broader again at the end.

I may note here that I call the lateral movable pieces valves or clasps. The flat expanded portion I so describe, or call it valve simply. The knobs, hooks, spines, etc., often double, that lie within this, basally and ventrally, but always firmly soldered to it, so that they move together, I call the harpe. The upper piece, with a single or double spine above and another below the anus, I call the tegumen. The central tubular piece of chitin I call the *ædœagus*, reserving the name of penis for the eversible membrane at the summit of this. There is often a membranous, or even more or less chitinous sheath at the base of the *ædœagus;* I call this the sheath. There have been

so many synonyms for all these parts that this explanation is probably desirable.

None of the following have any detected asymmetry except in the *ædœagus*.

The asymmetry of the *ædœagus* seems to be so universal in Sphinges that only a few, as examples of different manifestations of the tendency, can be given. They are not always referrible to any fundamental type.

*Acllopus fadus*.—There is no recognizable difference on the two sides, except in the *ædœagus*, which is long and slender, and has the opening to the right side, and beyond it, springing from the left side, is a long hair-like style, of about 2 m.m. in length.

*Sataspes infernalis*.—No very distinct unilateral variation is detected; the *ædœagus* is slender and delicate, and has no spines, etc., but it is not quite positively symmetrical; the whole of the appendages are of a very different type to any other species examined. The dorsal process of the tegumen consists of two widely-separated downward-directed hooks.

*Rhodosoma triopus*.—Very robust, especially the tegumen; the only unilateral structure is the termination of the *ædœagus*. The *ædœagus* is short and very thick, about 3·5 m.m. long and 0·7 wide; an extremely strong spine arises on the left side, and bending down at once, curves round beneath and close to the lower margin of the chitinous aperture of the *ædœagus*, its sharp apex reaching as far to the right side as that margin of the tube of the *ædœagus*.

*S. stellatarum*.—The *ædœagus* is very robust, the opening to the left. The right side carries a narrow longitudinal dark chitinous plate, with two rows of hooks directed backwards, this plate basally fades into the general tube structure, apically it projects beyond the tube in a thickened knob, with an angular end, and giving off on its dorsal margin a large scimitar-like spine or process that curves round the dorsal margin of the tube, and has a row of strong spines along its outer or upper edge. Within the tube are seen two long slender spatula-like pieces, which have probably something to do with the protrusion of the eversible membrane (the true penis?). I see these in this species, they probably exist in all in some form; the thickness of the *ædœagus* makes them more obvious here.

*Macroglossa belis* has the *ædœagus* very thick and with

the terminal spine starting dorsally, and curving round its dorsal margin to the left side.

*Macroglossa bengalensis* has a thick *ædœagus* with the right margin swollen and armed with spines. This species has *two* definite spines to harpe (like some Sphinges).

*Rhopalopsyche nycteris* has a very thick *ædœagus*, with chitinous slips included, it has a thickened margin dorsally and to the right, ending on the left in a hook following the margin of the terminal opening, with its sharp apex below the left margin, the distal margin of this hook or spine is armed by a row of sharp points.

In *Pterogon proserpina* the parts seem to be quite symmetrical except that the *ædœagus*, which is a chitinous tube, exposed for about 1 m.m. of its length, and about ·25 m.m. its diameter, is slightly expanded terminally, and appears to be longer on the left side, and to have a slightly projecting flanged margin at this side of the extremity. This flange is in fact a flange for about half its length, but its lower extremity is free, and terminates in a fine point. This free extremity, however, has the same curve as the portion attached to the margin of the tube, and is close to the portion of the margin of the tube to which it corresponds. The other extremity curving round the dorsal margin, curves in a basal direction, and so fades away on the right side of the tube.

*Enyo lugubris*.—The *ædœagus* is a rather long tube, with delicate transparent walls, and has a spine of stronger, darker tissue, in line with it projecting from left aspect of dorsum beyond left side of opening (like a bayonet on a gun-barrel). The length of this fine spine is nearly 1 m.m. There is no other appreciable asymmetry.

*Deidamia inscripta*.—The only lateral inequality is in the *ædœagus*, which is about 3 m.m. long and ·55 thick, at the extremity, a thick hook arises on the *left* side, and curves round the upper margin of the terminal opening, almost indeed partially over it, and terminates in a fine point on the right side. Comparing this with *R. triopus*, one queries whether a half rotation of the organ has not been made in one or other specimen in preparation. I describe what is before me; another preparation must be made.

*Ph. lineata*.—The *ædœagus* here is wide and short. The appearances might be produced, if first the tube were perfectly cylindrical, with a terminal opening continued ventrally by a longitudinal slit, then let the two sides of

the opening be pressed together, the left side yielding most; let the right side be a little longer than the left, and margined by a thick chitinous ridge, beginning by a thicker portion at the extreme dorsum, where the left side is hinged to it and is capable of moving to and fro, forming a lid or door; the chitinous margin gets narrower as it approaches the lower angle, ending in a point, its outer edge carrying a row of strong sharp spines. The appearance of this ridge is almost identical with the spine in *stellatarum*, but there it is free, here it is attached to the edge throughout its length.

*Ce. euphorbiæ.*—The structure of the *ædœagus* is very similar to that in *lineata*. The extremity is laterally compressed, and rounded from above downwards, the right side is firm, the left forms a valve or flap capable of closing against and within the right, or opening out. At the upper and lower angles are small soft processes. The right side has a thick chitinous margin, with hooks almost hidden along its basal margin, and smaller than those in *lineata;* except for its recalling *lineata*, it would not, as *lineata* does, suggest the considerably different structure of *stellatarum*.

*Ce. galii.*—The *ædœagus* has a delicate cylindrical tube, the angular termination is dorsal, and on the right (45°) it terminates in an angular margin like an arrow-head, added to it, *i. e.* at its central protruding angle it is a narrow piece, clearly marked off from (and raised above) the tube behind it, and continues so to each lateral point, these are nearly but not quite the same as each other, the lower (right one) running more directly basally, each carries several minute spines at its proximal end.

*Therctra lucasii* has the right side below strongly chitinized, towards the extremity of the *ædœagus*, above this, quite to the right side it is produced to a blunt point, longer than a similar process on the left side, from practically the extremity of this a short spine is directed upwards and a little to the left along the upper part of the left margin; its length is about ·4 m.m.

*H. celerio.* The *ædœagus* is a slender tube about ·3 m.m. in diameter, regular and cylindrical, on the right side somewhat dorsally is at the extremity a thickened darker chitinous piece produced to a point. One would say this was a symmetrical dorsal structure, and that the tube was turned round, dorsum to the right, 45°, were it not that there runs down from either side the apex outside

a ridge with fine serrations. On the upper dorsal margin this ridge is practically along the margin, on the lower (right) margin it is unarmed along the margin, but serrate where it runs almost directly forwards, along and parallel to the axis of the tube.

*Eu. elpenor.*—Symmetrical except the *ædœagus*, which has a ridge starting at the extremity dorsally, and passing obliquely forwards and to the left, and carrying a row of hooks or spines directed forwards (backwards if one calls the direction of the end of the penis forwards). The *ædœagus* is comparatively short and thick.

*Eu. porcellus.*—So far as asymmetry is concerned, the description of *elpenor* might be accurately applied to *porcellus*. There is some variation in individuals as to the oblique ridge. It is sometimes much less pronounced than in others. The genitalia are very much alike in these two species in all respects.

*D. idricus.*—There projects from the *ædœagus*, close to its extremity and on the right side, but close to the ventral aspect, a short hook, that projects downwards and curves to the left.

*Nephele viridescens.*—The prolonged and thickened margin of the *ædœagus* is here on the left side, but it is prolonged over the dorsum so that its very thickened end is nearly 60 to the right of the medio-dorsum, the thinned termination below to the left, almost reaches the ventral aspect. The margin of this flange has a series of rather long, very appressed spines. The thickened (right) end of the ridge projects some distance beyond the rest of the tube, and carries a short corkscrew-like spine, which is directed as it curls first distally then dorsally and finally to the right.

*Dilophonota ello.*—*Ædœagus* rather long and slender, terminating in an oblique opening, giving a sharp apex to right side. The lower margin of the opening has from this apex a ridge carrying a few sharp spines, the upper margin, from the apical point, runs more directly forwards in line with the tube, and carries a much greater number of very closely-packed smaller spines. The general scheme very similar to *Celerio*.

*Acosmeryx anceus.*—Margin longest right upper corner. A serrated flange runs down from this on lower (right) margin, and from the side of the extremity there is a spine directed to the left across the upper margin about ·5 m.m.

in length, the ridge running back dorsally does not appear to carry any spines.

*Acosmeryx cinerea.*—The parts are almost quite symmetrical. The opening of the *ædœagus* is terminal, and the right side seems rather more solid and armed by fine teeth, not clearly seen on other side.

*Sphinx pinastri.*—The *ædœagus* here is extremely long and slender, and terminates by slightly curving to the left. The right side is produced into a long process, of which about 1 m.m. is free, and nearly twice such a length runs back along the tube as a dark chitinous thickening. The tube is rather swollen along this portion. Apparently from the opposite side of the opening, but really, I believe, as part of the eversible membrane, that happens to be here displayed are two shorter more delicate processes that are placed against this longer process, one on either side of it. These two are not quite identical.

*Ag. convolvuli.*—The asymmetry, if present, is inappreciable.

*M. tiliæ.*—No asymmetry detected.

*M. atropos.*—Apparently quite symmetrical.

*Sphinx ligustri.*—There is practically no asymmetry. The prolonged triangular apex appears to be dorsal and without differentiation on its two margins.

*Ambulyx rostralis.*—The asymmetry here is reduced to a slight appearance, of the *ædœagus* being rotated a little, and some doubtful microscopic details. It is difficult to say positively that there is or is not asymmetry.

*Amorpha populi.*—The asymmetry here affects certain rather numerous very long thick spines on the eversible membrane at the opening of the *ædœagus*, these are more numerous, stronger, and distributed more distally on the left than on the right side.

*Smerinthus ocellatus.*—The eversible membrane here is armed with numerous spines as in *Sm. populi*, they are smaller and more curved than in *populi*. Their asymmetrical arrangement is quite subsidiary to the very marked structure of the termination of the *ædœagus*, which has an extraordinarily strong thick process on the left side, directed outwards, and ending in a rather sharp spine, curved so that the point is directed dorsally. The opening is thus thrown over to the left side.

This paper ought to include a reference to some facts recorded by Professor Poulton, as to asymmetry in the

male appendages, in his classical papers on the Morphology of Lepidopterous pupæ, in the Linnean Transactions for 1890 (Vol. V., Zool.), and especially those concerning *Hemaris fuciformis* on pp. 200, 206 and Plate XX, fig. 26. I have examined male pupæ of *Hemaris fuciformis*, *H. tityus* and *H. croatica* as well as of *Cephonodes hingii*, and all the specimens agree very closely with Professor Poulton's figure. All show the twisting of the two tubercles, so that that on the left side is more to the front and if anything larger and more prominent than that on the right, and have the furrow obliquely placed so that its anterior end points to the right, instead of directly forwards. They also show, as in Professor Poulton's figure, the posterior margin of the eighth segment, sinuated, opposite the advanced tubercle on the left side. He also figures less obvious asymmetry in *C. euphorbiæ* and *A. populi*.

In *Arge*, where he also detects pupal asymmetry, the structures render it very difficult in the imago to say whether there is any rotation of the *Ædœagus* or not.

These pupal facts render it probable that the asymmetry of the *Ædœagus* is at first (at least in some cases) really a twisting or rotation, and not, as it obviously is later in most cases, a difference in structure on the two sides.

Professor Poulton's caution, in noting the asymmetry in *H. fuciformis* as that "of the individual represented," and so avoiding a generalization for which he had not apparently the materials, is scientifically perfect. His surmise that the asymmetry may be an irregularity following from the extremely ancestral character of the organs does not seem to be borne out, the pupal asymmetry being almost certainly secondary to comparatively recently acquired imaginal asymmetry.

## Explanation of Plate XXIV.

Figs. 1–5. Appendages of *Cephonodes hylas*, L. (India).

Fig. 1. Seen from left side, × 8 diam. Shows relative size and form of left and of right clasps.

,, 2. Same from right side showing right clasp, × 8 diam.

,, 3. Extremity of *ædœagus* showing spine beyond opening, × 140 diam.

4, 5. Lateral and dorsal views of tegumen to show twist, × 9 diams.

,, 6. Left clasp of *Ceph. hylas*? (Africa?) showing somewhat different form, × 12 diam.
Torn end at separation shows want of definite articulation.

,, 7. Left clasp of *Ceph. kingii*, Macl., from within, × 7 diam.

,, 8. Right ,, ,, ,, ,, ,,

,, 9. *Ædœagus* of ,, ,, ,, ,, × 36 diam.
The *ædœagus* is shorter, more robust, and with the opening much further from the extremity than in *Ceph. hylas*, 0·7 m.m. instead of 0·3. In this, in the form of clasps, and in the trifling, if any, asymmetry in the tegumen, *Ceph. kingii* is much nearer to *Hemaris* than it is to *Ceph. hylas*.

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## Explanation of Plate XXV.

Figs. 1–4. Appendages of *Hemaris fuciformis*, L. (*loniceræ*, Zell.).

Fig. 1. Clasps expanded and seen from below (valves foreshortened), × 10 diam.

,, 2. Left clasp seen from within, × 10 diam.

,, 3. Right ,, ,, ,, ,, ,, ,,

,, 4. *Ædœagus* ,, ,, below, × 12 ,,

,, 4a. ,, ,, a little from the left, showing that opening is really terminal, and that the apparent point is really the thin margin of opening.

Figs. 5–9. Appendages of *H. tityus*, L. (*scabiosæ*, Zell.).

Fig. 5. Clasps seen from below (less separated than *fuciformis* in Fig. 1, their general relation to each other is the same in both species), × 9.

,, 6. Left clasp seen from within, × 11 diam.

,, 7. Right ,, ,, ,, ,, ,, ,,

,, 8. *Ædœagus* and bases of clasps from below, the point here is a true point 0·7 m.m. beyond the opening, × 15 diam.

,, Tegumen, lateral view, × 15. No asymmetry.

Figs. 10–11. *Ædœagus* of *Macroglossa stellatarum*, L.

Fig. 10. Shows hook which passes across dorsum to left side. The figure accurately follows preparation pressed on glass slide, in which the hook has been forced from its somewhat close apposition to the margin of the tube, × 15.

,, 11. The same to show eversible membrane extended with its two apparently asymmetrical chitinous filaments attached, × 12. This figure is rather from above, than a lateral view. Fig. 10 rather from below, but both are from flattened specimens.

XX. *The Protective Resemblance to flowers borne by an African Homopterous Insect,* Flata nigrocincta, Walker. By Sidney Langford Hinde. Communicated by Prof. Edward B. Poulton, M.A., D.Sc., F.R.S.

[Read June 4th, 1902.]

Plates XXVI and XXVII.

The "cluster of insects grouped to resemble a flower spike" which forms the frontispiece of Professor J. W. Gregory's "Great Rift Valley" (London, 1896) has attracted much attention and interest, as well as a certain amount of criticism. As I have had many opportunities of seeing the insect, and still oftener its larvæ, in the wild state, in British East Africa, and have drawings of both *in situ* made upon the spot by my wife, it seems desirable to publish the evidence.

Professor Gregory's plate was apparently drawn in England from his description and the dried specimens. In the insects grouped on the vertical stem the green individuals occupying the uppermost position (Fig. 1) are represented as considerably smaller than the red ones below, like the unopened green buds towards the top of a flowering spike as compared with the expanded blossoms below. On the other hand, the separate representations of the green (Fig. 3) and red forms (Fig. 2) of the insect, as well as the description on pages 273–275 of the work, indicate that there is no difference in size between the two. My own experience entirely confirms this latter conclusion, and there is no doubt that the impression conveyed by Fig. 1 is in this respect erroneous. Furthermore, the uniform deep pink colour of the exposed parts of the insects represented in Figs. 1 and 2 of the frontispiece is incorrect. The colours of the red forms of the living insect are as shown on the accompanying Plate XXVI, being of a bright orange-red anteriorly passing into a reddish-orange over the remainder of the surface exposed in the attitude of rest.

Furthermore, I have never seen the insects grouped according to their colours, but invariably mixed; I have

never seen the larvæ and imagines on the same stem or even together on the same tree or bush. I have never seen the imagines on vertical stems, but always on those which are actually or approximately horizontal.

It does not by any means follow that Professor Gregory was mistaken in his impressions, but it is certain that conditions other than those which he records are common. The discrepancy is not, however, to be explained by the hypothesis that I have been observing one species and Professor Gregory another. My material has been compared with that of Professor Gregory in the British Museum of Natural History by Professor Poulton, and he states both sets of specimens certainly belong to the same species, viz. a form slightly different from *Flata nigrocincta* (Walker), but evidently closely allied and perhaps specifically identical with it.

One criticism of Professor Gregory's plate and description we cannot sustain. I understand that the experienced African naturalist, Mr. W. L. Distant, holds that the position shown in Professor Gregory's Fig. 1 was merely due to the heavy rain which is stated to have occurred at the time (*loc. cit.*, p. 273), the insects having crept up the vertical stem to as great a height as possible in order to escape the wet. Mr. Distant accordingly believes that their grouping is unconnected with any protective resemblance to an inflorescence. My wife and I, on the other hand, recognize a strong superficial likeness between the mixed groups of insects and the flowers and buds of a leguminous plant with which we are perfectly familiar. We have mistaken the groups of insects for the flowers, and conversely the flowers for the insects. We unfortunately omitted to bring a piece of the plant to England in order that it may be identified, but this omission can easily be rectified on our return to East Africa.

Although, as I have said, we have never seen the imagines on vertical stems, the groups of larvæ were generally, although not always, in this position, as may be seen on Plate XXVII, reproduced about two-thirds of the natural size from a drawing made and finished upon the spot by Mrs. Hinde (Jan. 20, 1901). The locality was an island in the Athi River near the "Falls," about twenty-three miles from Kitui Station. There were dozens of groups on the shrubs and small trees under the shade of large trees on the island, and the group painted—a small

one—was that which was most convenient in position, about four feet from the ground. The long wax filaments so easily break that it was impossible to obtain satisfactory results by painting the captured larvæ.

The drawing of the imagines was made Jan. 23, 1901, at Kitui Station, from a branch of a bush which was covered with groups and single insects, although in both larvæ and imagines these latter are rare as compared with groups. The bush, which was small, was about fifteen feet high and ten feet in diameter.

When disturbed the imagines fly and the larvæ hop a short distance in any direction, but they soon begin to collect in groups again: the larvæ will have reformed into small groups in half-an-hour. The larvæ are often seen on rotten wood and dead leaves, but this is probably after they have been disturbed. Frequently too, I have seen the waxy secretion left adhering to branches where they have been. The larvæ seem to prefer a moist atmosphere and shade, although I have seen them in the broadest sunshine at Kibwezi, the locality where the insects were seen by Professor Gregory. The imagines I have observed in numbers on three or four occasions and in single groups several times. The groups of larvæ are usually about three or four inches in length, but I have seen a group as much as two feet long.

The larvæ towards the growing end of a branch are the smallest of the group (see Plate XXVII), and Professor Poulton suggests that this observation may perhaps reconcile Professor Gregory's account with ours. Professor Gregory, indeed, considers that the eggs of the *Flata* are laid from below upwards so that the insects towards the top of the stem would be the younger, and he thinks possibly immature (*loc. cit.*, p. 275). But the difference in colour cannot be due to immaturity, for we have found old, worn specimens of the green form. The first to emerge of any group may, however, be green, and those that emerge later red; and Professor Gregory may have come across undisturbed groups which therefore were green above and red below. Our groups, on the other hand, may have reassembled, and thus have lost the arrangement which it is possible they may have possessed on emergence from the pupal state. Specimens of larvæ and imagines captured at the time when the sketches were made were sent by us to the Hope Collection at Oxford.

## Explanation of Plate XXVI.

Protective Resemblance to flowers of British East African Flata nigrocincta (Walk.).

About $\frac{2}{3}$ of the natural size.

The sketch was made by Mrs. S. L. Hinde at Kitui on Jan. 23, 1901, and represents an actual group painted *in situ*. A red and a green form of imago are shown separately with their wings expanded. The Plate is a three-colour reproduction of the original painting.

## Explanation of Plate XXVII.

Larvæ of British East African Flata nigrocincta (Walk.).

About $\frac{2}{3}$ of the natural size.

The plate is a half-tone reproduction of Mrs. S. L. Hinde's original sketch made from the larvæ in the natural position, on an island in the Athi River near Kitui, on January 20, 1901. The two larvæ which are figured separately from the group were sketched in order to show the curiously different curves of the waxy filaments in two individuals.

## XXI. *Descriptions of some* Ants *from the Rocky Mountains of Canada (Alberta and British Columbia).* Collected by Edward Whymper. By Professor Auguste Forel, M.D., Hon. F.E.S.

[Read October 1st, 1902.]

1. *Myrmica rubra*, L., subsp. *brevinodis*, Emery, var. *frigida*, n. var. ☿.

The head longitudinally rugose, also at the sides, and nearly without transversal reticulations (in the typical *brevinodis*, the sides of the head are more reticulated). The abdomen highly polished, with only a few scattered erect hairs (more hairy and with slight, scattered puncture in the typical *brevinodis*). The whole body less hairy than in the typical *brevinodis*. Red; the abdomen and the upper side of the head brown. In all other parts like the typical form of the subspecies.

Ice River Valley, British Columbia, 5000 feet.

2. *Formica integra*, Nyl., ☿. Ice River Valley, British Columbia, 5000 feet. Very typical.

3. *Formica fusca*, L., var. *subaenescens*, Emery, ☿. Mount Goodsir, British Columbia, 7000 feet. Very typical.

4. *Formica fusca*, L., var. *neorufibarbis*, Emery, ☿ ♀. Vermilion Valley, Province d'Alberta, 6100 feet; Yoho Valley, 4600 feet; Ice River Valley, 5000 feet; British Columbia. Typical.

5. *Camponotus herculeanus*, L., var. *Whymperi*, n. var. ☿ ♀.

Very like the typical form of Europe, but the tibiæ and scapi abundantly covered with short, obliquely erected (half applied) hairs. In the typical form only a scattered and quite applied pubescence. The sculpture perhaps a little more strong, and the colour a little more dark than in the typical *herculeanus*. Professor Emery has already pointed out the stronger sculpture in speaking of the American *herculeanus*. Specimens of Hill City, South Dacotah, and of Northfield, are identical with those of British Columbia, and, I believe, that all American *herculeanus* belong to the var. *Whymperi*.

Ice River Valley, 4800—5000 feet; Banff, Province d'Alberta, 4500 feet (the ♀).

N.B.—The description of *Myrm. sabuleti*, var. *lobifrons*, Pergande, of Alaska, is so insufficient that it is not possible to ascertain this form. But the scapus of the var. *frigida* of *brevinodis* is very gradually curved at the base (more broken in *M. sabuleti*).

XXII. "*On the Tracheal System of Simulium.*" By Thomas Harold Taylor, M.A., communicated by Prof. Louis Compton Miall, F.R.S.

[Read October 1st, 1902.]

The tracheal system of the larva of Simulium (fig. 1) consists of a pair of longitudinal trunks running from the thorax to the posterior end of the abdomen. The two trunks are connected by dorsal commissures (fig. 1, *d*). Of these, there are three in the thorax, one between the pro- and mesothorax, one in the mesothorax, and one in the metathorax. There is also a dorsal commissure in the tracheal system of the head. Anteriorly the trunk ends abruptly between the pro- and mesothorax. Posteriorly it ends in the 8th abdominal segment, where it divides into a dorsal and a ventral branch. From each junction between two segments the tracheal trunk passes sharply downwards and then gradually rises to the junction next behind (see fig. 1). Near the lowest point of the curve arises the branch which supplies the segment (fig. 1, *v*). These segmental branches are present in the metathorax and each of the seven following segments. Each passes ventrally from its point of origin and divides into a descending and an ascending branch. At, or near the point of division there arises a fine branch, the initial thread, which runs towards the skin and ends in a spiracle. The last initial thread arises direct from the longitudinal trunk, and not from the segmental branch (fig. 1, *c*). The initial threads are solid and devoid of spiral marking.

Between the pro- and mesothorax, the longitudinal trunk gives off a slender branch which passes dorsally as the anterior dorsal commissure already mentioned. The trunk then bends sharply downwards, and after a short course divides into two branches which supply the head, pro- and mesothorax. At this point arises an initial thread, which is connected with the anterior thoracic spiracle. That part of the descending trachea from which the branches arise, and to which the initial thread is attached, may, from its ultimate fate, be conveniently described as the *spiracle-chamber* (see fig. 2). The corresponding part of the ventral

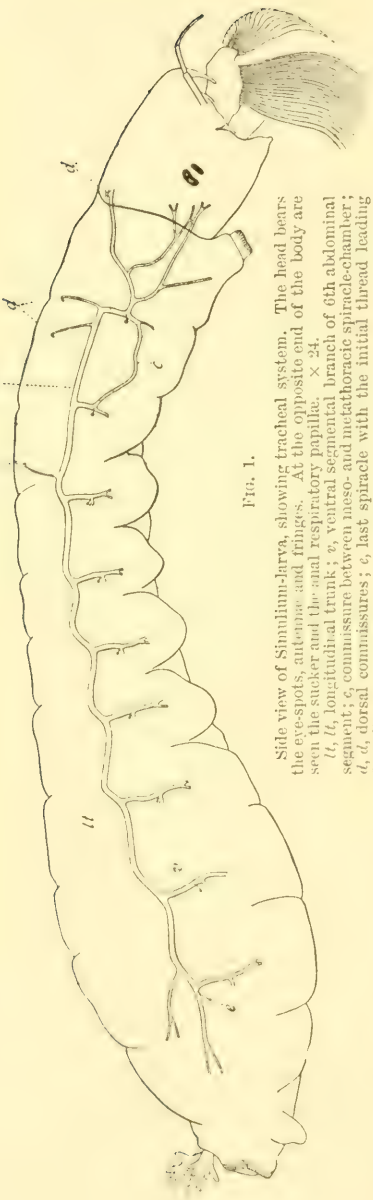

Fig. 1.

Side view of Simulium-larva, showing tracheal system. The head bears the eye-spots, antennæ and fringes. At the opposite end of the body are seen the sucker and the anal respiratory papillæ. × 24.
*lt, lt*, longitudinal trunk; *v*, ventral segmental branch of 6th abdominal segment; *c*, commissure between meso- and metathoracic spiracle-chamber; *d, d*, dorsal commissures; *e*, last spiracle with the initial thread leading from it.

branch in the metathorax may be similarly named. The position of the anterior thoracic spiracle is somewhat difficult to determine, but can be inferred from the following considerations. In old larvæ the developing pupal gill obscures the junction between the pro- and mesothorax. In larvæ in which the rudiment of the gill is beginning to develop a vertical muscle marking the intersegmental junction can be readily made out (fig. 2, *vm*). The spiracle is situated posterior to the muscle, and is therefore mesothoracic in position. Of the two branches which are given off from the spiracle-chamber one is anterior and the other posterior. Each again forks into a dorsal and a ventral branch. The dorsal member of the posterior branch unites with the succeeding metathoracic segmental branch (fig. 1, *c*). Each member of the anterior branch again divides, so that there are four tracheæ passing forwards, which may be numbered from above downwards the 1st, 2nd, 3rd and 4th. The 4th supplies the prothorax and its foot, the other

three the head. The 1st unites with the corresponding trachea of the other side by the head-commissure already mentioned. The 2nd and 3rd branches of the same side are connected together in the head by a short vertical trachea.

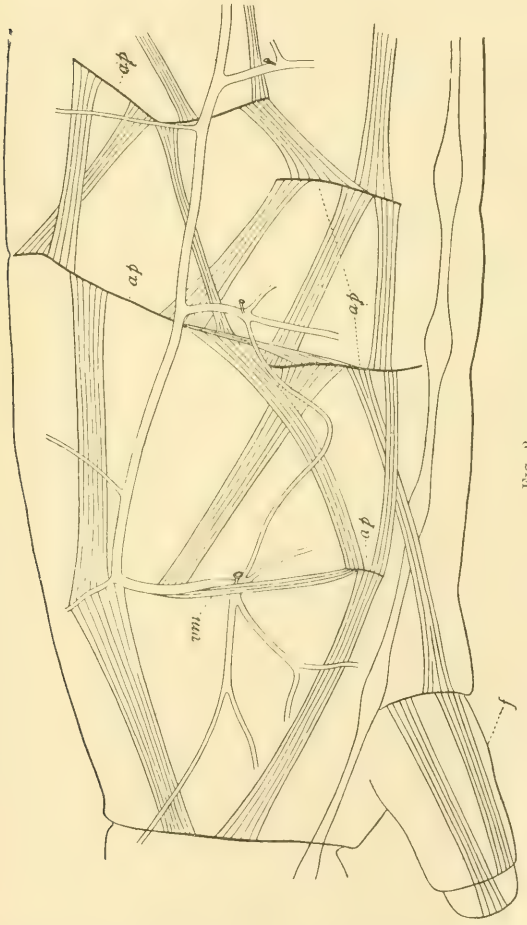


Fig. 2.

Thorax of Simulium-larva as a transparent object in side view. The muscles, tracheæ and nerve-cord are shown. The mesothoracic, metathoracic and 1st abdominal spiracles are seen. The initial threads from the spiracles proceed to the spiracle-chambers. × 75.
*vm*, vertical muscle marking junction between pro- and mesothorax; *f*, prothoracic foot; *ap*, apodemes marking junctions of segments

The tracheal system is renewed at each moult, the old one being cast with the skin. While the new tracheæ are developing, they enclose the old ones. It is evident that the new initial threads, which eventually become solid, must at this time be hollow. As the larva gradually disengages

the old cuticle from its body, the tracheæ, which are attached to it by means of initial threads are at the same time withdrawn through the new spiracles. To permit of this separation of the old tracheal system from the body, the tracheal trunks break across at certain points, which have a segmental arrangement. These tracheal junctions occur immediately posterior to the origin of the ventral segmental branches. At this point the spiral thickening of the intima is wanting. Junctions also occur on the transverse commissures. Two thickened annuli of chitin in the centre of the commissure replace the spiral intima, and the commissure snaps across between them. The withdrawal of the old tracheæ through the narrow opening afforded by the spiracle no doubt serves to squeeze the air from the old tracheæ into the new ones. Some air is, however, left sticking to the old collapsed tracheæ, as an examination of cast larval skins readily shows.

The spiracles are simple oval thickenings of the cuticle, and conspicuous from their black colour. The two thoracic and seven abdominal spiracles can be readily seen on the surface of the body with a low power. The mesothoracic spiracle is the largest of the series; the collapsed tracheæ which are pulled out through this spiracle from the head and thorax are much more numerous than those which are withdrawn from any of the other spiracles.

The tracheal system of the pupa (fig. 3) is modelled on that of the larva. The longitudinal trunks are connected by three transverse commissures in the thorax (fig. 3, *d*). Each trunk gives off in the abdominal segments 1—7 a ventral segmental branch, which divides into an ascending and a descending trachea. At their point of separation a slender initial thread passes to the anterior margin of the segment near which the spiracle is situated. The initial threads, like those of the larva, are solid and devoid of spiral markings. The spiracles are simply depressions of the skin. The spiracle of the first abdominal segment is concealed beneath the wing-sheath.

In the thorax the two pairs of spiracles have doubtless the same position as they have in the larva, but proof is difficult to obtain. The metathoracic spiracle is concealed beneath the wing-sheath. It is a wide, funnel-shaped depression of the cuticle, and is connected with the spiracle-chamber by means of a short thick initial thread. The

spiracle-chamber is connected with the longitudinal trunk by means of a short segmental branch, and the following branches lead from it: (1) a longitudinal commissure with the mesothoracic spiracle - chamber (fig. 3, *c*); about the middle of its course it gives off a trachea which runs in the sheath of the mesothoracic leg; (2) an ascending trachea which divides into a brush of tracheolæ; (3) a descending trachea which forks; (4) a trachea to the sheath of the metathoracic leg.

Fig. 3.

Pupa of Simulium in side view, the tracheal system being seen through the body-wall. The meso- and metathoracic and abdominal spiracles with their initial threads are shown in black. The filaments of the gill are cut short. × 24. *tt*, *tt*, longitudinal trunk; *c*, commissure between meso- and metathoracic spiracle-chamber; *d*, *d*, dorsal commissures; *cx*, tracheal extension.

The mesothoracic spiracle can be found most readily when the larval skin is being disengaged from the body of the young pupa. The old tracheæ of the head and part of the thorax are then withdrawn through the spiracle in question. It is situated a short distance behind the base of the gill. It becomes closed when the tracheæ are cast and the initial thread becomes solid. The spiracle-chamber gives off several tracheal trunks. Of these the longitudinal trunk and the commissure with the metathoracic spiracle-chamber have been already

mentioned. Of the remaining three branches, two have the same relations as the corresponding tracheæ in the larva. One supplies the sheath of the prothoracic leg; the other the head and fore part of the thorax. This last trachea divides into four branches which may be numbered as in the larva. The 1st is connected by a commissure with the corresponding trachea of the other side. The 2nd and 3rd branches of the same side are connected together as in the larva. The last trunk leading from the spiracle-chamber is met with in the pupa for the first time. It runs dorsalwards, and after a short course divides into an anterior and a posterior branch. Each of these breaks up into a copious brush of fine tracheolæ which supply the dorsal region of the thorax. From the posterior branch a slender trachea descends to supply the wing-sheath. The spiracle-chamber is put into communication with the pupal gill by means of a stout tracheal trunk which may be called the *tracheal extension* (fig. 3, *ex*).

The pupal gills of Simulium have been described by Vogler and others. They are paired, and carried on the fore part of the thorax. Each gill consists of a stem (fig. 3) which is short and thick, and of two (*S. latipes*) or four (*S. reptans*) branches, each of which divides into two long slender filaments. The stem projects forwards, and the filaments of each side lie nearly in one vertical plane. The filaments are transversely wrinkled, and taper gradually to a point. When viewed by reflected light under a low power of the microscope, the gill has a silvery appearance, but appears quite black and opaque when seen by transmitted light. After the gill is treated with caustic potash, transparent patches appear upon the filaments when viewed by transmitted light. These gradually enlarge and coalesce until the whole gill becomes transparent. The appearance of the gill is now dull by reflected light, and transparent by transmitted light. A similar result follows on the treatment of the gill with strong alcohol. By thus treating the gill with potash and with alcohol we learn that the filament is hollow, and that the wall is composed of a thick chitinous cuticle which resists potash solution. The chitinous cuticle is composed of two layers, a thin superficial and a thick deep stratum (figs. 4 and 5, *ss*, *ds*). The deep stratum is apparently quite homogeneous; it is very refractive, and stains readily with eosin and other dyes.

Separating the superficial from the deep stratum is a space about as wide as the deep stratum. This space is filled with air. It is to the presence of air in the chitinous

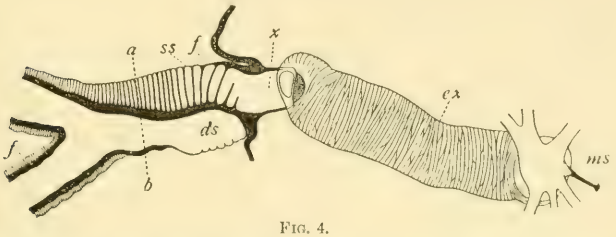


FIG. 4.

Tracheal extension and base of pupal gill. The gill-base is shown in vertical section the tracheal extension in surface view from the inner side. × 75.
*x*, communication between gill and tracheal extension; *f f*, chitinous fibrillæ; *ds*, deep stratum of wall of gill; *ss*, superficial do.; *ex*, tracheal extension; *ms*, meso-thoracic spiracle, with initial thread leading from the spiracle to the spiracle-chamber. The line *a b* indicates the plane of the transverse section (fig. 5).

wall that the silvery appearance of the gill when viewed by reflected light is due. Traversing this air-containing space and connecting the superficial with the deep stratum, are numerous delicate fibrillæ (figs. 4 and 5, *f*). These fibrillæ are simple at their deep ends, but tend to branch as they pass towards the superficial layer. They resist the action of hot caustic potash, and are probably chitinous like the rest of the wall. When the surface of a cleared filament is viewed by transmitted light, the points where the fibrillæ meet the superficial layer appear as bright dots which simulate pores. No apertures, however, occur in the wall of the gill.

The gill-stem differs from the rest of the gill in the arrangement of its chitinous layers. Four external surfaces may be distinguished: an upper, a lower, one turned towards the axis of the body, and another turned

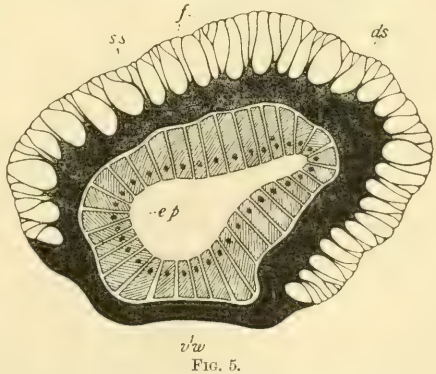


FIG. 5.

Transverse section of pupal gill, while still within the larval skin. × 300.
*vw*, compact ventral wall; *ss*, superficial stratum; *ds*, deep stratum; *ep*, epithelium; *f*, branched chitinous fibrillæ.

away from it. It is only on the upper wall of the gill-stem that the air-containing space is well developed. On the other surfaces the thin superficial layer becomes closely adherent to the deep layer, and the wall is rendered compact. As we approach the base of the gill-stem the contained air-space enlarges and the fibrillæ lengthen. This thickening of the dorsal wall of the gill-stem takes place at the expense of the internal cavity, which is consequently much reduced and perhaps quite obliterated. At the place of insertion of the gill the fibrillæ become fewer and farther apart, and finally disappear altogether. The air-containing space is now practically a tube excavated in the thickness of the cuticle of the dorsal wall of the gill.

The air-tube now leaves the gill, and enters the cavity of the thorax, in which it lies free. After a short course it ends abruptly by opening into a tracheal trunk (fig. 4, *c*). This tracheal trunk is the tracheal extension already mentioned. By means of this air-tube there is direct continuity between the air in the gill and the air in the tracheal system. Each gill has its own tracheal extension, by which it communicates with the mesothoracic spiracle-chamber of its own side. The tracheal extension (fig. 4, *ex*) is a wide tube lying near the wall of the thorax. The communication between the tracheal extension and the air-tube from the gill is not easily demonstrated, but its existence may be inferred from the following experiment. If a living pupa with entire gills be placed in strong alcohol, the air is rapidly driven out of the filaments, which consequently lose their silvery appearance. On replacing the alcohol with water, air soon reappears. The only possible source for the air is the tracheal extension. If the air be first removed from the tracheal extension, the filaments permanently lose their silvery appearance after the air has once been driven out by alcohol.

At the posterior end the extension is connected with the spiracle-chamber. At this point the chitinous intima loses its retiform thickening, and is developed into fibrillæ, which are similar to those that traverse the air-containing space in the gill. A perforated diaphragm is thus formed, which reduces the opening of the tracheal extension to a series of extremely minute apertures. No account of the meaning of this structure can be given.

From the preceding description it will be seen that the cavity of the gill is shut off from the cavity of

the body. Repeated examination of sections taken in various planes through the gill-base seems to make this point certain. It is also noticeable in these sections that the underlying epithelium is absent. In the developing gill in the larva, and for some time after pupation, the epithelium is present. It disappears eventually, and in preparations of old filaments presents a disorganised appearance. In an old pupa the filaments are frequently broken across, and it is not uncommon to find that foreign bodies, *e. g.* diatoms, have entered the cavity of the gill through the accidental opening. From these observations it seems likely that the interchange of gases between the gill and the surrounding water is carried on without the intervention of a cellular epithelium.

The respiratory organs of the pupa of Simulium have often been described as tracheal gills. Tracheæ, however, are quite absent, and Vogler (No. 6, p. 33) has therefore suggested the name *tube-gills* (*Röhrenkiemen*) for these structures. The filaments are certainly tubular; since, however, air does not occur within the cavity, but is confined to spaces excavated in the cuticular wall, it seems more appropriate to describe them as *cuticular gills.*

De Meijere (Nos. 1 and 2) has recently published accounts of the compound spiracles of Dipterous larvæ and pupæ. According to these observations, the original spiracle becomes closed, and the trachea leading from it to the adjacent tracheal trunk collapses and forms a solid cord. The closed spiracle De Meijere names the *outer stigmatic scar* (*äussere Stigmennarbe*); the solid cord, the *scar cord* (*Narbenstrang*), and the place where it joins the tracheal trunk the *inner stigmatic scar* (*innere Stigmennarbe*). The new larval or pupal spiracle arises as an outgrowth from the adjacent trachea close to the inner stigmatic scar. The outgrowth grows towards, and comes in contact with the skin. It becomes hollow, and contains a special chamber, the chitinous wall of which shows a retiform thickening, and is often clothed with a felt of hairs. This chamber De Meijere names the *felted chamber* (*Filzkammer*). At the place where the felted chamber becomes attached to the skin, the external cuticle shows thin spots which are named *pits* (*Tüpfel*), from their resemblance to the thin places in the walls of plant-cells. From the presence of these pits, the secondary spiracle is named a *pitted stigma*

(*Tüpfelstigma*). In the simplest case the stigmatic area on which the pits are grouped is flush with the cuticle. Generally, however, the pits are carried on one or more special budlike projections (*Knospen*) of the skin which contain prolongations of the felted chamber. In other cases the base of the pitted stigma is produced into a horn (*Prothorakalhorn*) which contains a continuation of the felted chamber, and carries the pitted stigma with its buds at the end. The distal portion of the felted chamber lying within the horn De Meijere distinguishes as the *felted chamber of the horn* (*Hornfilzkammer*) and the proximal part within the body as the *Narbenfilzkammer*. A further complication is brought about by the formation of a second pitted stigma on the felted chamber proximal to the original one. The original stigma may then be distinguished as the distal, and the second as the proximal pitted stigma. The old spiracle, now closed, and the adjacent new one together constitute what De Meijere calls the *compound spiracle*. The respiratory organ on each side of the thorax of Dipterous pupæ he regards as a prothoracic pitted stigma, differing from the similar organs of the larva and of the abdomen of the pupa only in its greater size. In rare cases the pitted stigma is absent and the respiratory function is performed by secondary structures (Chironomus).

From this account it will be seen that the gill-apparatus of the pupa of Simulium resembles the compound stigma of De Meijere in the following particulars: (1) The outer and inner stigmatic scars are connected by a solid cord (*Narbenstrang*, De Meijere; *initial thread*, Miall). (2) From that part of the tracheal trunk lying proximal to the inner stigmatic scar (*spiracle-chamber* of the present paper) a trachea with retiform markings (*Narbenfilzkammer*, De Meijere; *tracheal extension*, Miall) passes to the respiratory organ (*Prothorakalhorn*, De Meijere; *tracheal gill* of many writers; *tube-gill*, Vogler; *cuticular gill* of the present paper).

On the other hand the gill-apparatus of the Simulium-pupa differs from the compound stigma of De Meijere in the following respects: (1) The felted chamber of the horn is absent. (2) Stigma-pits and buds are absent. (3) The connection of the gill with the tracheal extension is made by means of a hollow cuticular ingrowth. From these observations there seems no reason to regard the

cuticular gill of the pupa of Simulium as a pitted stigma.

The development of the pupal gill begins in the young larva about the same time as that of the imaginal rudiments. It is noteworthy that this early origin of the gills in Simulium is not paralleled in Chironomus, where Miall and Hammond (No. 4, p. 124) find that "the dorsal prothoracic rudiments, from which the pupal tracheal gills of Chironomus proceed, are the last to be developed," and that it "is not till the larva is almost full-grown, and long after the other thoracic appendages are visible, that they appear." In the case of Simulium, the pupal gill and the imaginal rudiments make their appearance together. Of these, the dorsal prothoracic rudiment arises as an invagination of the epidermis, which takes place at the hinder end of the prothorax, immediately in front of the mesothoracic spiracle. The invagination gives rise to a shallow depression, lying at the side of the prothorax, whose wall becomes the sheath of the developing gill. The sheath, as seen from the outside, is semicircular in outline, with a straight and a curved margin. The straight margin runs obliquely upwards and forwards from the mesothoracic spiracle, and the rounded margin lies towards the anterior side. The wall bends sharply inwards along the straight edge, and is formed of a thickened epidermis. At its dorsal end an outgrowth of the thickened epidermis develops, and projects forwards and downwards into the cavity of the sheath as the rudiment of the gill. It soon divides more than once, and the branches become coiled up within the sheath. The gill-rudiment is hollow, and the cavity is continuous with the cavity of the body.

Dorsal to the gill-base and immediately behind the sheath a second invagination of the epidermis gives rise to a groove leading from the gill-base to the mesothoracic spiracle. The groove closes to form a tube (the tracheal extension), one end of which becomes continuous with the epithelium of the spiracle-chamber; the other ends blindly immediately below the gill-base. The epithelium of the tube secretes an intima on its free surface, which shows a retiform thickening. A thickening of the epithelium of the gill-base, which almost obliterates the cavity, grows inwards to meet the tracheal extension. The chitinous wall of the gill then becomes differentiated. The superficial layer with the fibrillæ forms first, and the homogeneous

deep layer later. As the cuticular wall develops it assumes a dark colour, which makes the gill a conspicuous object on the side of the thorax.

Fig. 6.

Bisection of Simulium-fly showing tracheal system. × 36.
*ll*, *ll*, longitudinal trunk; *d*, *d*, dorsal commissures; *sc*, mesothoracic spiracle-chamber; *sc'*, metathoracic do; *sp*, spiracle of 3rd abdominal segment.

When the larva is full-grown it weaves around its body a case, and then turns into a pupa. In *S. latipes* the whole

operation lasts about an hour, and requires considerable exertion, the larva bending its body in all directions as it pays out the silken thread. When the case is nearly completed, the larva pauses for a moment. The pupal extension suddenly fills with air, and becomes a conspicuous object on the side of the thorax. While the larva is putting the finishing touches to the pupal case, the air slowly creeps into the gill-base and along the filaments, which are still coiled up beneath the larval skin. It is an interesting spectacle to see the extension suddenly flash into view, and to watch the silvering of the filaments. When all is ready, the larval skin cracks, and the filaments, now filled with air, uncoil and project freely into the water flowing past.

The tracheal system of the fly (fig. 6) shows the same general arrangement as that of the pupa. The longitudinal trunks are connected by commissures, and the same branches with some additions are found as in the pupa. In the abdomen the posterior half of the longitudinal trunk and its ventral segmental branches give off many small tracheæ, which are unrepresented either in the pupa or larva. The tracheal extension of the pupa is unrepresented in the fly. The brushes of tracheolæ in the thorax of the pupa are replaced by vesicular tracheæ, and there is a general tendency, especially in the thorax, for the tracheæ to become dilated. In the abdomen open spiracles are present in segments 3—7 inclusive. Each consists of a small chamber with thickened chitinous walls of a dark colour, opening to the exterior, and also communicating by a short side-branch with the ventral segmental trachea. Spiracles have not been found in the first two segments of the abdomen. That they are present in some form may be inferred from the fact that in the pupa the tracheal remnants of these segments are withdrawn, and left attached to the cast skin when the fly has emerged. The thorax of the fly is provided with two pairs of spiracles, an anterior and a posterior. The position of these is not readily determined. It might be supposed that it would be safe to conclude that the homologous spiracle of the larva ought to afford an indication of the position of a spiracle in the fly. And if it could be shown that the generating epithelium was identical in the two spiracles, such evidence would carry weight. In the case of the anterior thoracic spiracles of Simulium, however, such an

identity cannot be demonstrated. The reverse seems to be inferred from the following considerations. In the larva the mesothoracic spiracle is connected with the spiracle-chamber by an initial thread. In the pupa the same arrangement is found, and in addition a tracheal extension connects the spiracle-chamber with the gill. In the fly it might have been supposed that the same arrangement as in the pupa would hold with these differences: (1) the tracheal extension would end blindly at the surface of the body in a scar marking the former insertion of the cast gill;

Fig. 7.

Thorax of Simulium-fly in side view. The pro- and metathorax with their appendages are dotted. × 45.
*s*, mesothoracic spiracle; *s'*, metathoracic do.; *ap*, apodeme marking junction of pro- and mesothorax.

(2) the spiracle would be open, and in communication with the spiracle-chamber by a hollow initial tube. The actual arrangement is, however, quite different. The epithelium of the initial thread and of the tracheal extension becomes flattened out, and takes part in the formation of the body-wall. The spiracle-chamber thus comes to lie close to the external surface, and the apertures of the initial thread and the extension coalesce to form the functional spiracle of the fly. The anterior thoracic spiracle of the fly is thus

a new formation, and does not correspond to the mesothoracic spiracle of the larva or of the pupa. The inquiry as to its position must therefore be made from data furnished by the fly itself.

Immediately in front of the anterior thoracic spiracle of the fly a well-marked apodeme (fig. 7, *ap*), or thickening of the cuticle, runs obliquely backwards to the mid-ventral line, where it unites with a similar thickening on the other side. The fore leg of the fly is inserted on the body in front of this apodeme, and muscles from the leg are attached to it. As the apodeme approaches the midventral line, it bears the antefurca, which, wherever it occurs, marks the junction of the pro- and mesothorax. The anterior spiracle of the thorax lies close behind the apodeme which carries the antefurca, and is therefore mesothoracic in position.

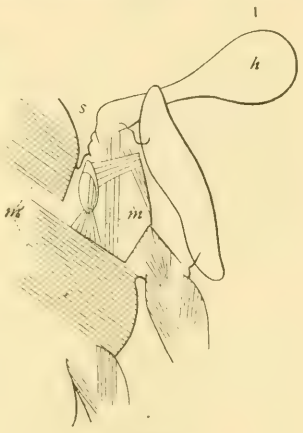


Fig. 8.

Vertical section of metathorax of fly. × 50.
*h*, haltere; *s*, spiracle with muscles, *m*; *m'*, mesothoracic muscles.

The posterior thoracic spiracle is formed out of the metathoracic spiracle-chamber of the pupa. It lies ventral to the haltere; immediately in front of it a deep suture occurs in the body-wall, which indicates the division between the meso- and metathorax. Further proof that this spiracle is metathoracic in position is afforded by sections. In fig. 8, which is constructed from sagittal sections, the muscles of the spiracle are seen arising from the same apodemes as the muscles of the haltere.

I desire to gratefully acknowledge my indebtedness to Professor Miall for proposing the subject of this paper, and for much help and kind interest during its preparation.

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## XXIII. *On* Heterogynis paradoxa, *Rmbr., an instance of variation by segregation.* By Thomas Algernon Chapman, M.D.

[Read October 1st, 1902.]

### Plate XXVIII.

Some years ago I had an opportunity of studying *Heterogynis penella*, and reported some of my observations to this Society (Trans. 1898). I had then no knowledge whatever of *H. paradoxa*, nor any particular hope of ever acquiring any. It was therefore with some pleasure that I came across the species this summer in sufficient numbers to enable me to become familiar with it in several aspects, and some of these seem to be of sufficient interest to be worth reporting.

The two species of *Heterogynis* are very much alike, so much so, that to question whether they are really distinct is by no means an irrational attitude. In all those points which makes the genus so interesting they seem to be identical, such as the curious specialization of the female pupa-case; the organic attachment to, and continuity of, the female moth with the pupa-case at the points where the true legs should exist, this attachment being the only trace of appendages the female moth has; her exact agreement in colouring with that she possessed in the larval state, differing in appearance from the larva only in being smooth and glistening, instead of dull and possessed of tubercles and fine hairs. They are the same also in the way in which the female moth emerges from her cocoon, and rests on the opened top of the pupa-case which partially protrudes from the cocoon, in pairing lasting only for some thirty seconds, and the moth retreating thereafter in five or six minutes into her pupa-case, and in this falling back into the cocoon. If the moth has been out of her pupa for some time, she takes a somewhat longer time to make her retreat. In both species the young larvæ when hatched eat up the remains of the parent moth, and then are possessed by an intense desire to wander. They then feed for a time, and hibernate by spinning a small

cocoon in some crevice of the food-plant or elsewhere. *H. paradoxa* does this, I find, in the second instar; Mr. Fletcher found *H. penella* did so in the third. Whether there is here a real specific distinction I cannot say, or whether there may be an error of observation on my part or on Mr. Fletcher's. The newly-hatched larva of *penella* is certainly much smaller than that of *paradoxa*.

On all these points and some others my observation of *H. paradoxa* yielded nothing that I had not already noticed in the case of *H. penella*, and of these I do not propose to go into any further details.

The circumstance round which most of my interest in *H. paradoxa* gathered, was in there being no less than three forms or races of the species met with in the small district in Spain we examined.

Bejar, which Mr. Champion and I made our head-quarters this summer for three weeks, is in a granite region, and is some 3300 feet above the sea. Above it the Sierra de Bejar rises to a height of nearly 8000 feet, and snow lay there in quantity up to the end of July, and does so in places I believe throughout the year. Brooms of half-a-dozen species are a very special feature of the vegetation here. *Genista florida* very much beautified the undergrowth in the neighbourhood of Bejar, but not going higher than 4000 feet at the outside. On the Sierra, *Cytisus purgans* begins about 5000 feet and goes up to nearly the top of the Sierra; it does not thrive or flower freely at its lower levels, but at about 6000 feet we found it forming dense masses of bloom covering thousands of acres, and most plants were not simply sheets of bloom but solid masses. Mr. Champion found, I think, that with the beetles, it was an exceedingly marked feature of the fauna that everything lived on the broom; this fact was not perhaps quite so striking in the *Lepidoptera*, but it was very marked. At any rate these brooms it was that made *Heterogynis paradoxa* one of the notable Lepidoptera of the region.

The first evening of our arrival at Bejar, viz. June 26th, I met with *H. paradoxa*, it was then fully out, and occurred close to Bejar at an elevation of about 3500 feet. The males were most easily found by looking over the plants of *Genista florida*, on the more elevated and separate twigs of which they were at rest, with their wings in some degree curled round the twig. If disturbed slightly, they

flew to a neighbouring twig, crawled up it, and settled down in the same way, but if really frightened, they would soar for a minute or two, and if there was any wind were liable to be carried right away. Only one or two were seen, early in the day, that were flying, without having apparently been disturbed. I took some more the following day, but a few days after had difficulty in finding one or two; it was in fact practically over, although a larva or two (ichneumoned ?) could still be seen. Its period of flight is therefore (in a late season) from about June 20th—30th. To avoid circumlocution I propose to call this form of *H. paradoxa*—var. *Bejarensis.*

On July 3rd, on the Sierra de Bejar, above Candelario, at a height of perhaps 5000 feet, I took several larvæ of a *Heterogynis* on *Cytisus purgans,* which grew from about that elevation up to fully 6500 or thereabouts—a species that clothed large areas of the Sierra, and made a mass of most splendid bloom at about 6000 feet, but below was already out of flower and had apparently bloomed there but sparsely. I took two or three more larvæ later. On July 12th these larvæ produced two ♀ imagines. So on the 16th I visited the locality to see if I could not capture some males. Sembling was of no avail, but I succeeded in capturing two or three dozen specimens. Only one or two of these were taken by observing them at rest, nearly all being disturbed by walking through and beating the broom bushes. The proportion of worn specimens showed they were a day or two past their best. This variety I call *Candelariæ.*

Later still, July 18th, at Piedrahita, some twenty-five or thirty miles from Bejar, and on an outlying ridge of the Sierra de Gredos, separated from the Bejar range by a rather wide valley, I met with a third form of *Heterogynis.* It was then only just coming out at its lowest levels, at its highest, 600 to 1000 feet higher up, only larvæ were to be seen. This form (*Piedrahitæ*) is therefore at least ten days later than *Candelariæ* in the date of its appearance. The chief interest attached to these three groups or colonies of *H. paradoxa* occurring within a limited region at successive dates, lies in the circumstance that each colony presented very definite characters by which it was distinguishable from the others.

Each group is thus probably entitled to a separate name on its merits; for convenience in speaking of them, how-

ever, it is almost a necessity, and so I have called them respectively var. *Bejarensis*, from Bejar on *Genista florida*, var. *Candelariæ*, from the Sierra above Candelario on *Cytisus purgans*, and var. *Piedrahitæ*, from the Sierra above Piedrahita, also on *Cytisus purgans*.

In average size *bejarensis* resembles the other two forms, viz. about 25 m.m., but ranges from 20 m.m. to 29 m.m., having a larger proportion of large and small specimens, is in fact more variable in this respect. The colour is a pale, diaphanous Indian-ink tint.

The larva is very similar to a medium-tinted one of *H. penella* in colouring, but like the other two forms, and unlike *penella*, it is fairly constant in colouring, no specimen ranging far from the average, whilst *penella* had no definite type, and specimens varied much in the proportions of yellow and black markings, some even being almost entirely black, others nearly without black markings. *Bejarensis* has a dorsal black line, or rather stripe, the subdorsal yellow band has two dark spots on each segment. The next dark band is well pronounced, and is connected by dark markings with the narrow dark line below, that runs along the spiracles; below this is an uninterrupted yellow band, and below this a dark band well defined above, below irregular, and more or less reaching to the prolegs.

The cocoon is dark-coloured, the male pinkish-orange (*penella*, lemon-yellow), the female deep orange almost red. The female cocoon is of very large size compared with that of *penella*. The female cocoon is placed conspicuously on the food-plant, sometimes on a separate projecting twig such as the male imago selects as a resting-place. The male cocoon, on the other hand, is usually well hidden, so much so that I only succeeded in finding one containing a living pupa, and only perhaps half-a-dozen altogether hidden away under stones, etc., all, perhaps, but the one living one, being remains from previous years.

The food plant was a broom *Genista florida* rather abundant close to Bejar, where it made a handsome show, but of which we saw little elsewhere. Amongst it grew another broom which was very close to, if not identical with common English broom. It occurred on this also, but very sparingly as though able to live on it when the larva had wandered on to it and had no choice, but neither liking nor thriving on it. It did not occur on other

brooms also growing close by, nor on any other plant, differing therein from *penella*, which prefers common English broom, has no objection to almost any leguminous plant, and is even almost omnivorous.

The form *candelariæ* appearing a full fortnight later than *bejarensis*, was a trifle smaller than that variety, and had not so great a range in size, varying from 22—26 m.m. in expanse, and averaging 24 m.m. The colour was distinctly lighter, a smoky-brown rather than a translucent black. Their habit of resting so as to be unseen, contrasted strongly with that of *bejarensis* and of *piedrahitæ*; the food-plant is the same as that of *piedrahitæ*, and though it does not afford such spray-like branches to rest on as the *G. florida* does, *piedrahitæ* always rested in the same manner as *bejarensis*. It is to be noticed that *candelariæ* thus hides itself as an imago, as well as a pupa; and so far as my observation went, as a larva also, as I found very few of these, but this might be due to my being too late for them. As compared with *piedrahitæ* on the same food-plant, it is to be observed that *candelariæ*, as an imago to be stirred up out of its food-plant, but not to be seen at rest, was, on a certain small area of a few hundred acres, very much more abundant than either of the other varieties in a similar space, but outside this small area it was not seen at all, although its food-plant extended a thousand or two feet higher up in the greatest profusion, as well as over other ground at the same level; whilst *piedrahitæ* occurred wherever the food-plant grew, over a large area extending both vertically and horizontally.

One is inclined to suggest that the bright lemon-yellow of the larva of var. *candelariæ* is correlated with the denser yellow masses of the flower of its food-plant, and that we saw nothing of it higher up where the broom was in flower, because it was so well hidden. This may very well be so, and it may have little bearing on the point that *piedrahitæ* on the same food-plant was not at all so hidden in any stage, nor was the larva modified in colouring like that of *candelariæ*.

The larva is quite yellow, the black-green markings being much reduced, only about a dozen larvæ were taken, but were all constant in this coloration. The ♀ moths bred from them agreed with them exactly in coloration as is the case in all specimens of the genus. This pale

larva is similar to the very palest that occur in *H. penella*, in which the larva varies much in coloration. It contrasts strongly with the much darker and unvarying larva of *bejarensis*, and with the palest forms of the dark, but less constant larva of *piedrahitæ*. The dorsal line is extremely slender, the subdorsal yellow is very wide, the subdorsal and spiracular black lines are slight and hardly connected together at all. The yellow is bright lemon colour, with no greenish suffusion from intrusions of dark spots from the black. The male moth is, as I have already referred to, more retiring in its resting habits than *bejarensis*. The pupa is, however, much more retiring. The number of males taken showed that the species must be at least quite as abundant as *bejarensis* is, yet only three or four (all injured) female cocoons were seen, and only one male one.

*Piedrahitæ* is larger than the other forms, chiefly by being of a more uniform size, and with few small and no very small specimens, ranging from 24—26 m.m., and averaging over 25 m.m. in expanse. It has not the pale colouring they have, but it is a comparatively dense black. The food-plant is apparently the same as that of *candelariæ*. The larva is close to that of *bejarensis* in colouring, it varies more than they do, some specimens being almost identical with those of *bejarensis*, but none at all so pale as *candelariæ*. The male imago has precisely the same habits as that of *bejarensis*, but in the matter of pupation it is closer to *penella* than to either of the other forms, ♀ cocoons being abundant and male cocoons tolerably numerous, but less so than females (the reverse of *penella*). I had about eight ♂ moths from collected cocoons, but the great mass of those I collected produced ichneumons. The healthy male larva therefore hides his cocoon more frequently than not, but does not invariably do so.

At Piedrahita I frequently met with larvæ spinning their cocoons, and found they did so in a very interesting manner, in those cases in which the cocoon was spun not between twigs but on the side of one. Having covered the twig sufficiently with silk, the larva, by successive series of fine loops of silk, constructs a lace-like veil on either side of the twig, and when these have attained sufficient dimensions draws them together over its back. The process is precisely the same as that adopted by *Nola* in spinning its cocoon, though *Nola* uses films of bark

fastened together edgewise of which to make the two veils, whilst *Heterogynis* uses only loops of silk.

Difference between the vars. of *H. paradoxa*, Rmbr.

| *Penella.* | | *Bejarensis.* | *Candelariæ.* | *Piedrahitæ.* |
|---|---|---|---|---|
| | Time of appearance | June 20–30 | July 12–20 | July 18–28 and later |
| 20–21m.m. | Size of ♂ | (40 specimens) 20–29 m.m. very variable, average 25 m.m. | (45 specimens) 22–26 m.m. not much variation, average 24 m.m. | (76 specimens) 24–26 m.m. very uniform, full 25 m.m. |
| Very dark | Colour of ♂ | rather dark | pale | very dark |
| Very variable | Larva, colour | rather dark, *i.e.* green-black marking strong, very uniform | very pale, *i.e.* green-black marking nearly evanescent, very uniform | pale and dark, none as pale as *Candelariæ*, variable |
| Often hidden | Cocoon ♀ | conspicuous (abundant) | hidden (found two destroyed ones) | conspicuous (abundant) |
| conspicuous | Cocoon ♂ | hidden (found *one*) | hidden (found) | conspicuous but usually (95 p.c.) parasitised a majority of healthy ones probably hidden (bred 8 moths) |

These three races of *H. paradoxa* appear to be as definitely distinct from each other, both as larva, pupa and imago, either in colour or habit or both, as if they were distinct species. Still I find it quite impossible to regard them as more than local races. Where I find something to learn from them is in considering how such definite races preserve their distinctness, although they are one species and live within a few miles of each other. In the cases of the vars. *corydonius* and *hispana* of *Lycæna corydon*, I was able to understand how one of these, *hispana*, was suitable to a limestone country, and *corydonius* to other conditions, but what I could not and do not at present understand, is how they keep distinct living on adjacent and practically sometimes on the same ground.

In the case of *H. paradoxa*, I can get a little nearer

comprehending how the three forms preserve their distinctness. It is, in fact, simply a case of segregation. Both species of *Heterogynis* are limited in their powers of dispersal by the female laying her eggs in her cocoon. All travelling from one area to another must be done by the larva. They are here in quite the same conditions as other species with apterous females. In most species with apterous females dispersal by larval migration is facilitated by a certain amount of polyphagous disposition on the part of the larva, this is certainly the case in *Orgyia* and in many Psychids. Even so, however, dispersal must be a slow process, and so far as such dispersal is concerned, it is quite conceivable that there might easily be enough separation of portions of the species even in continuous areas, to permit of distinct races arising. A further check to this, however, results from the male moth being usually very active and capable of flying considerable distances. Crossing thus readily takes place between colonies at considerable distances and imposes a serious impediment to any distinctive variation between them. In most years, a majority of adjacent colonies would thus be crossed with each other, and the result at the end of a few years would be that all colonies within a large area would be crossed with each other mediately if not immediately.

Considering the rather wide area of the range of *H. penella*, it probably, like so many other insects, has local races and varieties. But in the smaller regions within which I knew it, ranging from an elevation of 2000 feet at Digne to 8000 at Lauteret, and from Grenoble nearly to the Mediterranean, I am aware of the existence of no local variation at all comparable to that of *H. paradoxa* which I am describing. The almost polyphagous larva renders it capable of traversing, slowly of course, practically the whole of this area, and the male is I think more adventurous than that of *H. paradoxa*.

*H. paradoxa* is very differently conditioned; the larva is confined to a few food-plants. It is not like *penella*, polyphagous under some circumstances, nor even like it pleased with almost any leguminous plant. It must have broom, and not any broom. Out of six or seven plants that I called broom, *Cytisus* or *Genista*, and several other plants of the same and allied genera, it would eat only three, and one of these only as a substitute. There are possibly other brooms growing elsewhere in Spain that

please it, and it may even be variable in this point as in others, but it is unquestionable that at all its habitats where I met with it, each habitat was definitely and (to the larva of *H. paradoxa*) impassably circumscribed, by the limits of growth of its food-plants.

Crossing by migration of the male probably occurs, but it must be rarely. The male flies weakly, and never voluntarily undertakes a migratory excursion, but such must sometimes result from being caught by the wind.

The two races *Bejarensis* and *Candelariæ* live very close together, not more than three miles as the crow flies, but *bejarensis* is some 1500 feet lower than *candelariæ*, and on a S.E. instead of a north exposure; the consequence is that its flight is over before *candelariæ* comes out, so that the chances of any accidental crossing are much diminished if not entirely destroyed.

*Piedrahitæ* is separated by a wide valley from the two Bejar colonies, and curiously enough is even later in appearing than *candelariæ*, for no reason that I could observe, since it is at a level as low, possibly lower. At any rate any crossing with the Bejar forms must be all but impossible.

The segregation of these three forms from each other is, at any rate, if not complete, so nearly so as to make the differences between them easily accounted for by variation not swamped by crossing. There can be little doubt that the differences represent something that is or has been beneficial to each race, but here a longer study of the conditions affecting each colony would be necessary, even to plausible guessing. Why should *Candelariæ* hide itself so much more carefully than the others, as it does at all stages; as a result it appears to thrive at the one spot where I found it, but also as evidence that it has powerful enemies, it seems very restricted in habitat, whilst the other two forms are co-extensive with their food-plants. If there is anything in the suggestion that the larval colour is protective amongst the flowers of its food-plant, it is another item showing the need of protection in this form, since the flowers of the food-plant are nearly identical in colour in all cases, but with *Candelariæ* the flowers of *C. purgans* are denser than in *G. florida* and unmixed with leaves, but then *per contra* I only found the insect where the plant did not bloom freely.

The only other case in Lepidoptera where I have found

definite races due apparently to segregation from the females being apterous, is in the case of *Luffia ferchaultella*. As this species has no males, the segregation is of course even more stringent, and we find here that different races differ to the extent of having different numbers of joints in their tarsi (Tutts. Brit. Lep. Vol. II., Ent. Rec. Vol. XIII.).

Seeing that these three forms of *H. paradoxa* occur within a few miles of each other, and that the species occur over a very large area, how large I don't know, as I do not know precisely its range, but certainly I imagine several hundred miles across, there must be room for many other distinct races of the species, and the question may easily be asked whether such variations may not bridge over the difference between *H. paradoxa* and *H. penella*. Very possibly they may. It is not much use speculating, what is wanted is more knowledge of the colonies that probably exist in the northern half of Spain. Rambur named a third species, from the neighbourhood of Barcelona, but from very inadequate material. Kirby accepts this as a good species, all other authorities have treated it as merely *paradoxa*.

In the meantime the differences between *penella* and *paradoxa* are as definite as any usually considered sufficient to discriminate species. I have no hesitation in regarding them, as I know them, as abundantly distinct, even after making every allowance for the tendency of many species in Spain to be larger and paler than their northern representatives.

It may be useful to give a few notes on the differences between the species.

The newly-hatched larvæ present very important differences that have perhaps more specific value than any others.

The plate on the first thoracic segment has a dark mark of much the same form in both, but in *penella* it is darker shading on the plate, without very definite form, but shading off into the colourless part of the plate, while in *paradoxa* it is so definitely outlined that one takes it to be the actual plate of this peculiar form.

*Penella* has the usual tubercles with finely spiculated hairs, and the general surface of the skin is finely spiculated. *Paradoxa* has in addition a number of peculiar tubercles of which no trace exists in *penella*, these carry

no hairs, and are something very different from the true tubercles, yet when only slightly magnified they look just like them and are somewhat mystifying. The ordinary tubercle has a rather dark ring surrounding the base of the hair, and these special tubercles have also a dark ring of just the same size, and perhaps a little darker tint. This dark ring crowns a short conical column, and has about 10 to 12 sharp points round its margin. Without being at all like, they suggest the special tubercles of Limacodids. They are disposed one on either side of each of the dorsal tubercles, so that tubercles I and III with their eight attendant tubercles form a transverse row of 12 nearly equidistant points, whilst in the case of II the attendant tubercles are a little posterior to tubercles II, and so do not quite fall into a row with them.

There is a further very marked distinction between the two species, *penella* having only 7 crochets to the prolegs, whilst *paradoxa* has 11.

*Paradoxa* is larger than *penella*, and hibernates in second instar, *penella* in third.

In the full-grown larvæ, not having them side by side for comparison I may easily be at fault, but think there is no other difference than that of size.

The cocoons differ much in size and also in colour, that of *penella* being a pale lemon-yellow, of *paradoxa* a deep reddish-orange.

The male imagines are well defined by Rambur, Bruand, and others, in their descriptions of the species. *Penella* is smaller, darker, and much more densely scaled than *paradoxa*. This is especially noticeable in the body scaling. *Paradoxa* looks very thin and slight, and gives very much the same impression of being without scales on the thorax, whether they be absent or whether the somewhat evanescent and sparse clothing is still present, the abdomen is but little better furnished, whereas *penella* looks a solid, robust little fellow entirely in consequence of his thick fleece.

*Penella* has a more robust-looking antenna, with longer pectinations. The length of the pectinations persists till towards the end of the antenna, whilst in *paradoxa*, the shortening begins comparatively near the base. On both 36 pairs of pectinations may be counted; these are almost quite constant in *paradoxa*, but often vary to 32 in *penella*.

The anterior tibial spurs in *penella* arise near the middle

of the tibia, in *paradoxa* about ⅔ from the proximal end, the longer spur (*penella*) being, as it so frequently is, correlated with the most plumose antenna.

I have not seen it noted that each antennal joint carries two pairs of the pectinations, so that there is only half the number of antennal joints that there at first seems to be, 2 basal and 18 (not 36) with plumules = 20 varying in *penella* to 19 and 18.

The parasites of *H. paradoxa* are very destructive to it. My notes might refer to two sets of parasites, one of *bejarensis*, the other of *piedrahitæ*. I believe they would be more correctly interpreted as referring to ♂s and ♀s, but the latter view would have to be modified by a strong suspicion I have, that what appear to be male cocoons are really merely the cocoons of larvæ that are to grow no larger, because they are parasitised, and so spin a small cocoon that one takes for that of a male larva, whereas it may be really a female whose growth is checked by the parasite.

However this may be, I collected many ♀ cocoons of *H. bejarensis*, and from them bred many Tachinid diptera of a smallish species (*Blepharidea* (*Ceratochæta*) *presia*, B. B.); one specimen of a larger species was also bred from a Piedrahita ♀ (the same species also emerged from *Orgyia aurolimbata*), also many Chalcids. No male *bejarensis* having been collected, no parasites were bred from them.

Many male, or apparently male cocoons were collected at Piedrahita, of which some 95 per cent. produced ichneumons. These were of two species. One spins an oval cocoon within that of the *Heterogynis*, after emerging from the larva of its host, and produces *Casinaria orbitalis*, Gra. In the case of the other, the *Heterogynis* either changes to pupa or appears to die as a larva, in both cases *Pimpla scanica*, Vill., emerges, by cutting out a lid in the dead skin of its host. In two instances at least a *Pimpla scanica* emerged from a cocoon of the *Casinaria*. As hyperparasitism is not recorded for Pimpla (I believe), and as the present species is a simple direct parasite on the *Heterogynis*, the hyperparasitism must here be an accident; the larva of *P. scanica*, finding its host occupied also by a larva of *Casinaria orbitalis*, solved the awkward situation by entering the body of its fellow-guest, as it must have been within the *Casinaria* when that spun its cocoon. Such at least is a possible explanation, though it involves

a rather improbable attribution of instinct to the Pimpla larva. Another explanation offers itself. The *Heterogynis* larva must be not unfrequently stung by both parasites as they are so common; what will happen in this case? Since no larva produced two parasites (we may assume that each species only stings a larva once, recognizing and avoiding one already stung by its own species), either they grow *pari passu*, and both perish for want of pabulum, or one destroys the other; if it does this by treating the other as part of its host's tissues and devouring it, we have again no outward indication that two parasites were at any time present. But suppose the *Casinaria* larva already well grown at the time the *Pimpla* stings its victim, then using its piercing ovipositor, it, quite by accident, as it were, pierces also and lays her egg in the *Casinaria* larva, the result would be what I observed, the *Casinaria* would be so far ahead of the *Pimpla* as to make its cocoon. The condition would be one of ordinary hyperparasitism so far as procedure goes, but as regards intention and instinct would be purely accidental. It presents, however, no matter how we explain it, a very interesting accident as affording material which might be elaborated by natural selection into true hyperparasitism.

## Explanation of Plate XXVIII.

Larva of *Heterogynis paradoxa*, Kamb. (First stage.)

Fig. 1. Dorsal view × 20, showing tubercles and pseudo-tubercles.

Fig. 2. Portion of same × 250. Below 1 is a tubercle; below 2 and 3, its two attendant pseudo-tubercles.

December 30, 1902

THE

# PROCEEDINGS

OF THE

# ENTOMOLOGICAL SOCIETY

OF

# LONDON

FOR THE YEAR 1902.

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## February 5th, 1902.

The Rev. Canon FOWLER, M.A., F.L.S., President, in the Chair.

*Nomination of Vice-Presidents.*

The President announced that he had appointed Mr. FREDERICK DUCANE GODMAN, D.C.L., F.R.S., Professor EDWARD B. POULTON, M.A., D.Sc., F.R.S., and Dr. DAVID SHARP, M.A., F.R.S., F.L.S., as Vice-Presidents for the Session 1902—1903.

*Election of a Fellow.*

Dr. NORMAN JOY, of Bradfield, near Reading, was elected a Fellow of the Society.

*Exhibitions.*

Professor E. B. POULTON exhibited with a lantern a series of slides prepared by Mr. Sanger-Shepherd for Professor Meldola, from specimens in the Hope Department of the Oxford University Museum. He pointed out that the Sanger-Shepherd three-colour process enabled us to preserve a permanent record of mimetic and synaposematic groups, of which the components have been brought together from all parts of a vast collection, such as those exhibited to the Entomological Society, by Mr. Walter F. H. Blandford, on May 5, 1897, and

described in the Proceedings for that year (p. xxi). These specimens had been selected with great expenditure of time and pains by Mr. Blandford and the late Mr. Osbert Salvin, but the groups were now broken up, and the specimens restored to their places in the systematic series.

The first slide represented a large group of butterflies from British Guiana, showing the strong development of black pigment in the hindwings of many *Heliconiinæ* and *Ithomiinæ*, as well as in a species of *Lycorea* (*Danainæ*), *Stalachtis* (*Erycinidæ*), and *Dismorphia* (*Pierinæ*). The number of individuals was probably as great as in any of the groups shown by Mr. Blandford, and yet each was reproduced with sufficient distinctness on the lantern-slide, to bear magnification for purposes of demonstration on the screen.

The insects were arranged on a background of grey paper in order to be photographed. The most convenient arrangement consists of a series of corked boards about 1 ft. × 1 ft. 3 in. in area, sliding in grooves in a case, so that they cannot be displaced in any position. The setting should of course be flat, and the specimens as far as possible at one height.

The slides represented (1) groups of *Limenitis* (*Basilarchia*) *archippus*, taken at the same time and place with its model *Anosia plexippus*, in various localities in Canada and the United States; (2) Chalcosid moths from Borneo with their Pierine and Euplœine models; (3) Xylocopid bees from Borneo and Mashonaland, with their dipterous mimics belonging to the genus *Hyperechia*; (4) A large composite group, captured by Mr. Guy A. K. Marshall, at Salisbury, Mashonaland, in which numerous species of Coleoptera of various families, of Aculeate Hymenoptera, of Hemiptera, two species of Lepidoptera, and one of Diptera, all possessed Lycoid colours, and a Lycoid pattern, the models consisting of several species of *Lycida*, from the same locality. Nearly the whole of these species appeared to be pseudaposematic, the only probable mimics in the Batesian sense being the fly, and one or two Longicorns; (5) A group of European *Vanessidæ*, compared with (6) a group of five species, and (7) a pair of species of *Acræina*, captured by Mr. Marshall on the veldt at Salisbury in a single day, showed the striking resemblance

which is so common between sets of species of a specially defended group inhabiting the same district; (8) A group from North Kanara, obtained by Mr. Keatinge, showing *Papilioninæ* and *Nymphalinæ*, resembling the local *Euplœinæ*, and also the close superficial resemblance between the different genera of the latter, recalling the synaposematic *Acræinæ* of slides (6) and (7); finally slides (9) to (12), illustrating injuries to the wings of butterflies, probably caused by the attack of enemies, especially birds. All the specimens had been captured by Mr. Marshall at Salisbury. A large number of the injuries were inflicted at the apex of the forewing, in the very place where a bright mark or white band tends so frequently to be developed; in a far larger number the injury had been inflicted at the anal angle of the hindwing, on one or both sides, in the latter case the two notches or tears fitting together when the wings were closed in the attitude of rest. This also is a spot at which special structures and markings tend to develop—the prolonged angles of some species, the numerous tails of *Charaxes*, the single tails of *Papilio*, *Protogonius*, *Anæa*, and especially the *Lycænidæ*, in which special eye-like marks and special movements tend still further to direct attention to the spot, and divert attack from the more vital parts. Comparatively few of Mr. Marshall's specimens had been injured at any other point of the wing contour.

A discussion on the subject followed, in which Colonel Swinhoe, Mr. F. Merrifield, Dr. Chapman, Mr. C. O. Waterhouse, the Rev. F. D. Morice, and Colonel Yerbury took part, Mr. Verrall observing that in the case of Diptera they mimicked other groups rather than were mimicked by them, while there were even cases in which flies fed on dragon-flies, and not *vice versa*, as was usual.

With regard to the protective value of the scent-glands present in groups allied to the *Chalcosiinæ*, and conspicuous also in *Anthrocera*, Mr. J. W. Tutt said it was possible that they might have something to do with edibility or otherwise of the species. The glands, though better developed in the male, existed also in the female. Professor Meldola, however, supposed them to be characters of sexual attraction, as laid

down by Fritz Müller, and therefore not affecting the question of distastefulness.

Mr. C. G. Barrett exhibited a series of the perfect insect of *Glottula fusca*, Hpsn., together with ears of maize (locally called mealies), showing the damage done by the well-grown larva of the species, which lives in the first place in the stem, eating the pith from the ground, and afterwards attacking the cobs, and eating from the inside into the bases of the unripe grains which then change colour and shrivel up. He also exhibited: *Gynaniza maia*, ♂, Walk., and a drawing of the larva; *Nudaurelia menippe*, ♂, Feld., and drawing of the larva; *Bombycomorpha bifascia*, Hpsn., circlet of eggs, cocoons and figure of the larva; *Phissana flava*, Feld., food, cocoon and figure of the larva; *Gonometa postica*, ♂ and ♀, Walk., cocoon (poisonous), and ♂ and ♀ figures of the larva; *Henucha smilax*, ♂ and ♀, Feld., pupa, cocoon, figures of the larva, and an enlarged segment to show markings; *Metarctia rufescens*, Walk., and figure of the larva; *Tæniopyga sylvana*, Walk., and figures of the larva; *Rigema ornata*, Walk., and figures of the larva—all the foregoing specimens and figures being received from Miss Frances Barrett, Buntingville, Transkei, South Africa.

Mr. W. L. Distant exhibited two specimens of Coleoptera which he had received alive from the Transvaal—one *Anthia thoracica*, Thunb., which had since died, the other *Brachycerus granosus*, Gyll., still living. These insects had been sent him by Mr. Robert Service, of Dumfries, on the 9th December last, who wrote: "I received a small packet of 'odds and ends' from my friend Sergt. Peter Dunn, of the volunteer company of the Scottish Borderers, which regiment was in the vicinity of Krugersdorp with Lord Methuen when Dunn wrote. Several of the beetles showed signs of life, so I took them into the greenhouse, bathed them in the hot-water tank, and then put them in a suitable case. Three of them came round nicely, and were soon as lively as possible; one escaped, the other two I now send you. The *Anthia* is inordinately fond of small earth-worms, the other I have not seen eat anything, but it may have fed on some of the green things supplied. The night that these prisoners of war travelled from Scotland to my home was a frosty one, and the *Anthia* never recovered

from its effects and died soon afterwards. The *Brachycerus* has now been in the concentration camp of my greenhouse for about two months; has apparently eaten nothing during that time; has periods of apparent lifelessness, and subsequent fits of great activity, as was seen at the British Museum yesterday."

Mr. Distant remarked that the genus *Anthia* extends to the Southern Palæarctic region, and there seems little doubt that these species could be easily acclimatized there. All they require at home is the run of a good palm or orchid-house, but whether they would be a horticultural blessing is of course doubtful.

Mr. R. Adkin exhibited a series of *Acidalia aversata*. The parent moth (a banded female, the male parent not being known) was taken at Lewisham in June 1900. Of the resulting larvæ about one half fed-up rapidly, and produced imagines in the autumn of the same year—a very unusual circumstance in the habits of the species; the remainder hybernated and produced imagines in June of the following year, thus occupying the normal time in completing their metamorphoses. The proportion of individuals following the female parent in the two portions of the brood was almost equal, the percentages being approximately 53 banded in the autumnal emergence as against 58 in the spring, but in point of sex the disparity was great, over 65% of the autumn moths being males as against fully 72% females in the spring portion.

Mr. G. C. Champion exhibited long series of *Leptura stragulata*, Germ., and *Strangalia pubescens*, Fabr., from the pine-forests of Aragon and Castile, showing the great variation in colour of the two species in these districts, whereas the allied forms occurring in the same places, viz., *L. rubra*, Linn., *L. distigma*, Charp., *L. unipunctata*, Fabr., and *L. sanguinolenta*, Linn., were perfectly constant; also *Dermestes aurichalceus*, Küst., which he and Dr. Chapman had found everywhere in abundance in the old nests of the processionary-moth (*Thaumatopœa pitocampa*, Schill.) on the pines in these forests.

Dr. T. A. Chapman exhibited in illustration of his paper living larvæ of *Hypotia corticalis*, Schiff, as well as preserved larvæ, pupa-cases, imagines, and prepared wings to show the neuration of that species.

*Papers.*

Dr. T. A. Chapman, F.Z.S., read a paper, "On a new subfamily of Pyralidæ."

Mr. Edward Meyrick, B.A., F.Z.S., communicated "Descriptions of new Australasian Lepidoptera."

Mr. W. F. Kirby, F.L.S., communicated a "Report on a Collection of African Locustidæ, chiefly from the Transvaal, made by Mr. W. L. Distant."

## March 5th, 1902.

The Rev. Canon Fowler, M.A., F.L.S., President, in the Chair.

*Election of Fellows.*

Dr. B. Douglas Macdonald, M.D., of Malsette, Rhodesia, S. Africa; and Mr. Arthur M. Montgomery, of the Grove, Ealing, W., were elected Fellows of the Society.

*Exhibitions.*

Mr. L. B. Prout exhibited on behalf of Mr. J. P. Mutch, of Hornsey Road, London, N., a specimen of (*a*) *Vanessa* (*Eugonia*) *polychloros*, L., a ♀ bred by Mr. H. Baker from a pupa from Stowmarket, Suffolk, the ground-colour of which was much darkened and the black markings somewhat enlarged, etc.; suggesting perhaps the influence of cold at the time of pupation (compare *Tr. Ent. Soc.*, 1894, p. 431, etc.). He also exhibited an aberrant specimen of (*b*) *Chrysophanus phlæas*, L., captured in the Isle of Wight, in August, 1901, much suffused with dark colour, especially at the outer margin and on the hindwings, only a very small patch of the red colour remaining at the inner angle of the latter; also a perfectly-halved gynandromorphous example of (*c*) *Agrotis puta*, Hb., the right side ♂, the left side ♀, taken in August, 1901, in the Isle of Wight. He also showed a specimen of (*d*) *Noctua sobrina*, Gn., an aberrant specimen with white antennæ and a somewhat hoary appearance on the forewings, taken in East Aberdeenshire, in August, 1900.

Mr. A. Bacot exhibited a series of *Malacosoma castrensis*

and a series of *M. neustria* for comparison with a hybrid brood, resulting from a pairing between a male *neustria* and a female *castrensis*. Only a portion of the batch of from 200 to 300 ova that the female laid hatched. Of the ova that did not hatch, some were found to contain fully-developed, but dead larva, while in other instances the eggs were quite empty. Continuing, Mr. Bacot said :—"The young larvæ were healthy and did not differ perceptibly from a brood of young *castrensis*, except in regard to their rapidity of growth. Either just before or just after their second moult the brood divided into two portions ; one of which grew rapidly and the other very slowly, so that it became necessary to separate them for convenience of feeding. The 'forwards' were very healthy—I do not remember a single death—and they fed up at an unprecedented rate, producing the female specimens exhibited. The 'laggards' fed slowly, were unhealthy, and weakly, the total number of emergencies being seven out of some thirty that spun up ; these were all males, and, judging by the size of the larvæ, the remainder of the 'laggards' that did not emerge were of this sex. The last of the females that emerged was three weeks ahead of the first male, and most unfortunately before any males of either of the parent species, so that the fertility of the hybrid females could not be tested. Their bodies apparently contain few, if any, ova. I have every reason to believe, however, that I obtained pairings between the hybrid males and females of *castrensis*, in addition to fresh pairings between males of *neustria* and females of *castrensis*, and therefore have hopes of continuing the experiment next summer."

Mr. J. W. Tutt said this was the first time any exhibition of experiments of the kind had been made before the Society by British investigators, though Mr. Merrifield had shown a number of crosses bred by Herr Standfuss. In this case the colouring of the ♀ hybrids, departing from the usual colour of the ♀s of the parent species, appeared to approach more nearly in tint to the ♀s of the closely-allied Alpine species *Malacosoma alpicola*, and it would be interesting to discover whether this peculiarity of colour in the hybrid ♀s really marked a tendency to revert to a more primitive ♀ type of

coloration—such, for example, as that exhibited by ♀ *M. alpicola*. The sexes, as exhibited, were very clearly distinguishable, and there was not much tendency to gynandromorphism, though of sixty or seventy specimens almost every ♀ showed some signs of ♂ coloration.

A discussion of the relative preponderance of the sexes in gynandromorphous forms followed, in which Canon Fowler, Colonel Swinhoe, and the Rev. F. D. Morice joined.

Mr. O. E. Janson exhibited a pair of *Stephanocrates dohertyi*, Jord., a Goliath beetle discovered by the late W. Doherty in the highlands of British East Africa.

Dr. T. A. Chapman exhibited cocoons of a *Limacodid* moth from La Plata, with empty pupa-cases of a dipterous parasite of the genus *Systropus*, obtained from Herr Heyne, who unfortunately had no imagines either of the moth or fly.

Dr. Chapman said:—"Herr Heyne was under the impression the pupa-cases were those of the Limacodid moth. I mention this, not as a reflection on Herr Heyne, who would no doubt have recognized what they were, had he really examined them, but as showing what a close resemblance there is between the two pupa-cases; I have placed with them some genuine Limacodid cases, with their cocoons, to illustrate this. The resemblance is, however, not merely of appearance, but functional also. The moth-pupa, *i. e.* the moth itself inside the pupa-case, almost certainly by inflating itself with air, to secure greater size and a stiffened epiderm as a basis of muscular action, exerts an end-to-end pressure within the cocoon, and so forces off a lid. This lid is not prepared by the larva, in any special sense; the cocoon is brittle, and the form of the cocoon makes this lid the easiest line of fracture under the forces exerted. This is seen to be the case by the fracture being somewhat irregular, and different in each cocoon, and may be proved experimentally, as I will immediately mention. The fracture is also determined at the precise line in which it occurs, and the forces acting upon the cocoon are intensified at one point, so as more easily to start the fracture, by the sharp beak (or 'cocoon-opener') with which the pupa is armed. This beak acts, not by cutting, but by bringing the strain on the cocoon to a more definite form at one point.

The experiments I refer to are simply this: if a sound cocoon be taken, and with say the point of a penknife, an attempt be made to remove such a lid, a fracture starts at the spot where the penknife is applied, and a lid at once breaks off. This lid is very similar to the one the moth makes, but is less symmetrical, and may be considerably larger or smaller than that is, and always starts at the point where pressure is applied by the sharp implement. It is therefore similar to the lid the moth makes, but not the same lid, and shows that such a lid occurs wherever the forces applied determine, and not along a specially-prepared line. The experiment is, indeed, even more conclusive than this. It is not always easy to say of a sound cocoon, which end is which, and if the wrong end be attacked, a lid is removed just as correctly as at the right one. It is here that the beak or 'cocoon-opener' is useful as determining that the fracture shall be at the right end, making the lid split off here, under much less pressure than would be efficient without it, and leaving no chance for fracture to occur at the wrong end where pressure is equally distributed. The *Systropus* breaks off a similar lid, no doubt by similar end-to-end pressure to that exerted by the moth, *Diptera* having highly developed the habit of inflating themselves with air, at emergence from the pupa. This pupa also has a beak very like that of the Limacodid, but even stronger and sharper. I have put in the box a Bombyliid pupa-case from West Africa. It is very like that of some British forms. The head-armature is not a 'cocoon-opener,' but an excavating or navvying machine, for use in burrowing a way out of loose soil, such as that in which solitary bees' nests are found. The pupa of an African species of practically the same habits as this South American one is described and figured in Prof. Westwood's monograph of the genus *Systropus* in our *Transactions* for 1876."

Mr. J. E. Collin, in further illustration of Dr. Chapman's remarks, exhibited specimens of: (*a*) *Systropus*, sp.? from Buenos Ayres, parasitic on a Bombycid Lepidopteron (*Limacodes*?). This he said was possibly the same as Dr. Chapman would have reared from his cocoons. The species was apparently undescribed, but most allied to *S. brasiliensis*, Meg.

As Prof. Westwood noticed in 1876, the insect is a very slender one to inhabit so stout a pupa-case. (*b*) *Systropus*, sp. ? A large handsome undescribed species from Bigot's Collection.

*Papers, etc., read.*

Prof. E. B. Poulton, F.R.S., gave an account of a paper by Mr. Guy A. K. Marshall, entitled "Five years' (1897–1901) Observations and Experiments on the Bionomics of South African insects, dealing especially with Warning Colours and Mimicry, with Appendices containing descriptions of new species by Colonel C. T. Bingham and Mr. W. L. Distant." The paper not only contained Mr. Marshall's account of his researches, but the unrecorded notes of many other naturalists bearing on the same subjects, together with numerous quotations from Mr. Marshall's letters to Prof. Poulton and the full description of a large number of specimens illustrating insect bionomics sent by him to the Hope Collection at Oxford. These latter will be permanently retained in the bionomic section of the collection, where they can be studied by any naturalist visiting Oxford. Perhaps the most important part of the memoir consists of a full description of the long series of observations and experiments, conducted, with great care, upon South African insect-eating animals. The insect enemies made use of were spiders, *Mantidæ*, lizards, frogs, kestrels, the Ground Horn-bill, the Mongoose, and the Baboon. Exact observations of birds in the wild state capturing butterflies are also added, together with a statement of the insects, etc., found in the digestive canal of birds, and numerous specimens of butterflies which, from the character of the injuries received, appear to have been attacked by enemies. The experiments on the *Mantidæ* are of the highest importance, several genera being made use of, and the researches continued for many weeks or even months in the case of certain species. These predaceous insects freely devoured such forms as *Mylothris* and often even *Limnas chrysippus*, while the *Acræinæ* were evidently distasteful to them. Some of the series of experiments rendered it probable that *Acræinæ* are poisonous, or at least unwholesome food to the *Mantidæ*. The experiments on

kestrels and baboons were also very numerous and important. As regards the Lepidoptera the support afforded to the theories of warning colours and mimicry was very striking. Another feature was the great use made of Coleoptera and the strong witness to the distastefulness of the conspicuous groups such as the *Lycidæ*, *Melyridæ*, *Cantharidæ*, etc. As a result of these experiments and the work of other naturalists, the attempt is made to draw up a list of the Coleopterous groups which correspond to the Rhopalocerous *Ithomiinæ*, *Danainæ*, *Heliconinæ* and *Acræinæ*. The chief of these are the conspicuous, convergent, frequently mimicked and presumably distasteful *Erotylidæ*, *Endomychidæ*, *Malacodermidæ*, *Melyridæ*, *Coccinellidæ*, *Cantharidæ*, and *Chrysomelidæ*.

The memoir also contains the evidence produced by Mr. Marshall in refutation of Haase's conclusion that conspicuous specially defended butterflies are not attacked by insect parasites. The conclusion of Profs. Plateau and Wheeler that human experience of the taste of insects affords trustworthy evidence of their effect upon the senses of insectivorous animals is examined in the light of Mr. Marshall's experiments and found to be unsound.

The remarkable mimicry of Curculios with a cryptic colouring by Longicorns is discussed, and the conclusion reached that the defence provided by such a quality as hardness does not appeal like distastefulness to many classes of enemies irrespective of size, and that the concealment afforded by protective resemblance is necessary against the considerable number of foes which are strong enough or large enough to attack successfully.

The mimetic resemblance of *Mantispidæ* to Hymenoptera, already recognized in North America (Wheeler) and Borneo (Shelford), is further illustrated by a fine example from South Africa. The use of insect stridulation as a means of warning or intimidation is discussed. The experimental evidence of the value of the terrifying markings and attitudes of *Chœrocampa* larvæ is strengthened by the remarkable impression produced by an African species upon a pair of baboons. As bearing on this section it is shown that *Chœrocampa elpenor* is still an object of superstitious dread in Ireland. The shorter notes

deal with such subjects as "The courtship of Limnas chrysippus," "The meaning of the sac of female *Acræinæ*," "A Rhodesian muscid fly parasitic on man," "Evidence of terror caused by the squeak of *A. atropos*," etc.

The material described in the paper illustrates many varied aspects of mimicry, warning colours, and common warning colours from the points of view provided by several very diverse orders of insects. The most striking contribution to the subject is probably the remarkable group of synaposematic insects with a Lycoid colouring (already described on p. ii), and the varied assemblages which are made up by Hymenoptera Aculeata with well-marked types of colouring, each being attended by insects of other orders, many of which are undoubtedly Müllerian components, while others may be Batesian, although the latter interpretation can only be accepted as probable in a very small proportion of the examples. Among these groups perhaps the most important consists of insects which are entirely black with iridescent blue-black wings. No less than twenty-eight convergent species of Aculeates form the centre of an assemblage, round the periphery of which are scattered Hemiptera, Diptera, Coleoptera (*Cantharida*), with a single Zygænid moth. In another group of almost equal importance the colouring is similar to the last, except that the posterior end of the abdomen is bright yellow or orange. In another the whole abdomen is yellow, and the wings transparent: another is similar to the first described Aculeate-centred group, except that the head is red: another differs in having a yellowish head, thorax, etc. Not only the Aculeates but other specially protected South African insects sent by Mr. Marshall form beautiful synaposematic groups, sometimes included within the limits of a single order, sometimes attracting insects of other orders. Thus one group of conspicuous little beetles consisted of six species of Phytophaga, belonging to six genera, at least one Melyrid, and a Curculionid. The black-and-orange banded Cantharid type comprise many species, and a few different genera of these Coleoptera, together with two Longicorns, two Phytophagous beetles and a Hemipteron, make up a strong and characteristically marked combination. The Hemiptera form well-marked and apparently self-contained

groups, one with a conspicuous pattern of black and red with a black membrane, or a white membrane through which the black body is more or less clearly seen; another pale yellow with black transverse bars. The first of these groups is composed of Lygæid and Reduviid species, the second of Pyrrhocorid and Reduviid. To return to the Aculeate-centred groups, the *Mutillidæ* are resembled by *Carabidæ* and *Cicindelidæ*, and yet there is also a secondary resemblance between these two latter, which becomes primary in the case of species which do not resemble the *Mutillidæ*. In other cases small slender *Carabidæ* of the genus *Atractonota* primarily resemble ants in movement and appearance, and yet secondarily resemble other species of *Carabidæ* in the markings by which these latter resemble the *Mutillidæ*. These complex interrelationships suggest proto-, deutero-, and perhaps tritosynaposematic resemblances for the Müllerian associations, proto-, deutero-, and perhaps, tritopseudaposematic resemblances for the Batesian.

Another important group has for its centre three species of ants, resembled by a Pyrrhocorid bug of a new genus, *Megapetus*, described by Mr. Distant in his Appendix, and a little Locustid of the genus *Myrmecophana*, with the parts of the body which would interfere with the likeness to an ant obliterated, upon the plant on which the insect occurs, by their green colour. Examples of all these were taken on one plant in a single day.

Nearly all groups here shortly described were illustrated by photographs projected on the screen. A brief account of some of the chief results of Mr. Marshall's work was read before Section D of the British Association at Bradford (1900), and published in abstract in *The Report* (p. 793).

The number of new facts is so large, the experiments so numerous and complete, and the range of observation extended over so many orders in addition to the usually-studied Lepidoptera, that this memoir places South Africa in the first rank as the country from which the chief evidence in support of existing theories of Mimicry, Warning Colours, etc., has been supplied.

A discussion ensued in which Mr. F. Merrifield, Dr. F. A.

Dixey, Prof. Hudson Beare, Colonel Yerbury, Mr. J. W. Tutt, and Prof. Poulton took part.

Mr. Malcolm Burr, B.A., F.L.S. contributed "A monograph of the genus *Acrida*, with notes of some allied genera, and descriptions of new species."

Dr. D. Sharp, F.R.S., communicated three papers by Mr. R. C. L. Perkins, respectively entitled:

(*a*) "Notes on Hawaiian Wasps, with descriptions of new species";

(*b*) "Four new species and a new genus of parasitic Hymenoptera (*Ichneumonidæ*) from the Hawaiian Islands;" and

(*c*) "On the generic characters of Hawaiian *Crabronidæ*; four new genera characterized."

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## March 19th, 1902.

Mr. Frederick DuCane Godman, D.C.L., F.R.S., Vice-President, in the Chair.

*Election of Fellows.*

Mr. Benaiah W. Adkin, of Brandon House, Morden Hill, Lewisham; Mr. E. D. Bostock, of Texall Lodge, Stafford; Mr. Hubert Edelstein, of the Elms, Forty Hill, Enfield, Middlesex; Capt. Frederick W. Hutton, F.R.S., of the Canterbury Museum, Christchurch, New Zealand; Mr. Frederick William Lambart Sladen, of Ripple Court, Ringwould, Dover; and Mr. Gerard Orby Sloper, of Westrop House, Highworth, Wiltshire, were elected Fellows of the Society.

*Exhibitions.*

Mr. W. J. Kaye exhibited a number of insects from British Guiana, many of them taken by himself, illustrative of Müllerian mimicry. An extensive series of Heliconine dark hind-winged species, was made up of *Melinæa mneme*, *M. crameri*, and *M.* ? n. sp., *Mechanitis doryssus*, *Lycorea atergatis*, vars., and *Heliconinus cetustus*. Another particularly interesting group consisted of *Lauroa partita*, a *Hypsid* moth, *Ithomia zarepha*, an Ithomine butterfly, and *Stalactis evelina*,

an Erycinid butterfly, the last mimicking the Ithomine, and the *Hypsid* moth sharing the dangers by mimicking the Ithomine.

Mr. DuCane Godman remarked that in these regions many different forms of the same butterfly would often occur within a radius of fifty miles, showing a wide range of variation.

Professor E. B. Poulton exhibited cocoons of *Malacosoma neustria* collected by Mr. Hamm in 1900, spun upon black-currant and apple-trees in his garden at Oxford. All of them had been attacked by birds through the leaf, this being the thinnest part of the cocoon, and the pupa thus more easily abstracted. With regard to the resting habit of *Hybernia leucophearia* he said that Mr. Hamm had observed that this moth usually rested with its body in a horizontal position. In this way the light and dark markings of the wings appeared vertical, fitting in with the shadows of the natural cracks and crevices of the oak bark.

Dr. Longstaffe said that all the specimens he had observed on green stems affected a similar position, and that he had only found one on a birch-tree. Mr. M. Jacoby said that he never found the species on oak at all, but on palings, also in the same position, which facts Professor Poulton said tended to show that the protective instinct of the species was retained in such localities.

Mr. G. T. Porritt exhibited two bred black *Larentia multistrigaria* from Huddersfield, and said that the dark form was rapidly increasing in Yorkshire. Of those already emerged and reared from the same brood, three were normal and two dark.

*Papers, etc.*

Dr. Frederick A. Dixey, M.A., M.D., read a paper, illustrated by lantern slides, entitled :—"Notes on some cases of Seasonal Dimorphism in Butterflies, with an account of Experiments made by Mr. Guy A. K. Marshall, F.Z.S." He said that he had long since formed the opinion that *Catopsilia crocale*, Cram., was specifically identical with *C. pomona*, Fabr., and had suspected that the differences between them might prove to be seasonal in character. The belief in their specific identity was held by Piepers and by de Nicéville,

neither of whom, however, thought that the dimorphism thus shown had any relation to the seasons. On the other hand, Batchelor had found that in Queensland the two corresponding forms were associated with the summer and autumn season respectively. Similarly, *Catopsilia gnoma*, Fabr., could not be separated specifically from *C. pyranthe*, Linn. In this case de Nicéville not only held the view of their specific identity, but also allowed that for part of their range *C. pyranthe* was associated with the wet season, and *C. gnoma* with the dry. This raised a presumption in favour of the accuracy of Batchelor's observation with reference to *C. pomona*. An objection that had been brought on the score of the different habits of *C. pomona* and *C. crocale* could not be taken as valid, for analogous differences of habit existed in the case of *Precis sesamus* and *P. octavia-natalensis*, which had been absolutely proved to be the same species. Altogether, though the direct proof which would be afforded by breeding one form from the other was still lacking, the evidence as to the respective specific identity of these forms of *Catopsilia* was very strong, and the presumption as to at any rate *some* correspondence with seasonal conditions was hardly less so. On taking a wide view of the question, it became evident that many forms, either known or reasonably supposed to be "seasonal," varied considerably in their relations with meteorological conditions. It was not unusual, in some localities, for the so-called "wet" and "dry" forms to be on the wing together in good condition. Examples of this were numerous in the genera *Teracolus* and *Terias*. This was no doubt due, in some cases, to a mere "overlapping" at the change of seasons, but there were well-attested instances of the simultaneous occurrence of diverse "seasonal" forms during the entire period of flight of the species. On the whole it seemed that in many moist districts, such as the equatorial region of West Africa, the "wet-season" forms preponderated; while such forms were rare in some dry districts such as Scinde. But in other dry spots, like Aden and Karachi, there was much evidence to show that all the seasonal forms of certain species occurred together. A well-marked alternation of forms did not take place unless there

was a well-marked alternation of seasons, and not always even then. These facts suggested questions which could only be answered after the collection of further data. Meanwhile, Mr. G. A. K. Marshall had done much to extend our knowledge of the subject by his recent observations and experiments carried on in South Africa. Besides the case of the production of *Teracolus auxo* from eggs laid by *T. topha*, which had been already announced by Mr. Trimen, he had by actual breeding experiments raised the question of the identity of other pairs of named forms from the region of conjecture to that of positive proof. This statement was illustrated by the exhibition of one of the specimens of *T. auxo* above referred to; and of parent individuals of *Teracolus achine*, *T. omphale*, *Terias senegalensis*, *Byblia vulgaris*, and *B. ilithyia*, accompanied in each case by their offspring, which belonged respectively to the forms *Teracolus antevippe*, *T. theogone*, *Terias æthiopica*, *Byblia götzius*, and *B. simplex* (African form). Mr. Marshall had also succeeded in proving the sensitiveness of certain forms in the pupal state to artificial conditions of humidity and temperature. Heat unaccompanied by moisture had caused in *Byblia ilithyia*, *Pinacopteryx pigea*, and to a less extent in *Crenis boisduvalii*, an approach to the "dry-season" coloration; while in the presence of moisture in addition to heat, the "winter brood" of *Teracolus achine*, *T. omphale*, and *T. phlegyas* showed a tendency to revert to the garb of the rains. Moisture without heat produced a slight determination towards the rainy season form in *Crenis boisduvalii*, and a more decided one in *Pinacopteryx pigea*. These effects, though unmistakable, were far less striking than those obtained with European species by artificial conditions of temperature in the hands of Merrifield and Standfuss.

In the discussion which followed Colonel Yerbury said that a temporary rainfall in a dry season in dry places had a marvellous effect in producing intermediate and wet-season forms.

Mr. F. Merrifield said he thought it highly creditable to Mr. Marshall that, situated where he was, he had been able to obtain such valuable scientific results. It was

very desirable that further experiments of an exhaustive character should be tried on the relation of moisture and dryness, carefully dissociated from temperature, to dimorphism. Though the dimorphism in the South African species of *Precis* —to take a striking example—was quite as great as the seasonal dimorphism of the well-known *Araschnia levana*, the two different forms of it did not appear so exclusively associated with the different seasons as was the case with the latter species, the two forms of the *Precis* being so frequently found together. Perhaps this was because the two seasons—the wet and the dry—were not usually in tropical and subtropical countries so sharply differentiated from each other as were the winter and summer seasons in the temperate regions. As regards Dr. Dixey's paper, he thought it an extremely valuable one in bringing up to date the existing knowledge on the subject, in giving the reasons for the conclusions he had arrived at with sufficient fulness to enable others to appreciate them, and in summing up these conclusions so that they might remain in the memory and form so conveniently the groundwork for the further investigation of this and allied questions.

Professor E. B. Poulton expressed his opinion that by breeding species through, Mr. Marshall had proved that one form gives rise directly to the other; the pairing of the two forms being a biological test of very considerable value.

Colonel Swinhoe, Dr. Jordan and Mr. F. DuCane Godman also joined in the discussion.

Professor E. B. Poulton, F.R.S., read a paper on "Mimicry illustrated by the Sanger-Shepherd three-colour process," supplementary to his paper read at the last meeting of the Society.

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## April 16th, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of Fellows.*

Mr. James Roland Charnley, of Howick House, Howick, near Preston, Lancs., and Mr. A. T. Gillanders, of Park Cottage, Alnwick, were elected Fellows of the Society.

*Exhibitions.*

Mr. O. E. Janson exhibited specimens of both sexes of *Ornithoptera victoriæ* from Ysabel, Solomon Islands, recently taken by Mr. Albert Meek, and remarked on the variation in the colour and markings in the males.

Mr. H. W. Shepheard-Walwyn exhibited a series of *Euchelia jacobææ* taken by him at Winchester in July 1889. Among the specimens exhibited were one ♂ of normal size with very pale coloration: one ♂ in which all the crimson was replaced by lemon-yellow, without a trace of pink: and one ♂ of normal size but rather paler than the type common to the district.

Mr. Willoughby Gardner exhibited *Cœlioxys mandibularis*, Nyl., from the Cheshire coast, a species new to Britain; and *Osmia xanthomelana*, ♂ and ♀, and *Osmia parietina*, Curt., ♂ and ♀ from North Wales.

Mr. A. J. Chitty exhibited a specimen of *Aglais urticæ* taken at sallow on March 28th, having a large portion of the hind wings cut off so that when folded they were symmetrical in outline. From their appearance he concluded they had been bitten off by some animal, probably during hybernation.

Dr. T. A. Chapman called attention to the remarkable bilateral asymmetry in the male appendages of the Hemarid Sphinx, *Cephonodus hylas*, Linn. He said that bilateral asymmetry in insects was sufficiently rare to make it always notable. In the male apophyses of Lepidoptera he had only been able to find records in the case of the Hesperid genus Thanaos, to which Scudder and Burgess first called attention—though it seems highly probable that the facts can hardly have been unobserved in so common a species as *C. hylas*. In Hylas the right clasp is larger, rounded, but very imperfectly articulated to the base, so as to be capable of very little movement, otherwise, and compared with other Hemarid genitalia, one would call this the normal clasp. The left clasp looks at first as though it had been the same as the right, but had met with some accident that had removed a large terminal disc, leaving two lateral cusps. It is shorter than the right as about 3 to 5, and the arrangement of bristles and spines is quite different to that on the right, if it is indeed possible to

compare these very different forms. It is much more movable than the right clasp. The arrangement suggests that it is intended to facilitate a lateral, instead of a medial approach in the capture of the female. The upper appendage or tegumen is also twisted, so as no doubt to correspond with the obliqueness of the whole appendage, as most definitely seen in the clasps. Dr. Chapman also exhibited specimens of the several parts removed from the insect, as well as sketches of the clasps and tegumen.

Mr. C. P. Pickett exhibited specimens of *Hybernia leucophaaria* taken during March at Chingford, Highgate, and Finchley, including the ordinary mottled, the black and white banded, and six very deep chocolate-coloured forms, one unicolourous. He also showed series of *Phigalia pedaria*, *Anisopteryx æscularia*, and *Nyssia hispidaria* from the north Metropolitan district.

Mr. H. J. Turner on behalf of Mr. W. West, of Greenwich, exhibited male and female specimens of *Stictocoris flaveola*, Bohm., a species new to the British fauna, found amongst long grass in damp places at Lee, Kidbrook, and Shooter's Hill, and identified by Mr. Jas. Edwards and Dr. Sahlberg. The species is described by Mr. Edwards in the January number of the E. M. M., vol. xiii, pp. 5-6. He also exhibited several specimens of *Typhlocyba candidula*, Kir., a species first discovered by Mr. West at Lewisham and Blackheath on *Populus alba*, and remarked that it was interesting to find two quite new species occurring in the district so well worked by Douglas and others in years past.

*Papers.*

Dr. D. Sharp, F.R.S., communicated a Paper by Miss Alice L. Embleton, B.Sc., "On the Economic importance of the Parasites of Coccidæ."

Colonel Charles Swinhoe, M.A., F.L.S., read a Paper entitled "Eastern and Australian Drepanulidæ, Epiplemidæ, Microniidæ and Geometridæ in the British Museum Collection."

Mr. William F. Kirby, F.L.S., contributed a Paper entitled "Additional Notes on Mr. Distant's Collection of African Locustidæ."

## May 7th, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of Fellows.*

Mr. Charles R. Chichester, B.A., M.B., L.R.C.P., of Bathurst, Gambia, West Africa, and Clonmore, co. Cork, and Mr. J. H. Lewis, of Ophir, Otago, New Zealand, were elected Fellows of the Society.

*Exhibitions.*

Mr. H. W. Shepheard-Walwyn exhibited a gynandromorphous specimen of *Euchloë cardamines*, taken near Winchester in 1899. The left wings were those of a normal male, the right those of a normal female, with the exception of a splash of orange pigment on the underside of the primary.

Mr. H. Goss exhibited two male specimens of *Saturnia carpini* from Essex, bred on whitethorn, and three males of the same species caught in Surrey by the aid of bred virgin females. He remarked that as a rule bred specimens were smaller than caught ones, but the bred Essex specimens were much larger than those captured in Surrey. The Essex specimens were light in colour, while the Surrey specimens were not only much smaller in size, but very dark, probably because their larvæ had fed upon *Erica* or *Calluna*.

Colonel C. Swinhoe announced the emergence of *Cossus ligniperda* in the Zoological Society's Gardens from a pupa received in a piece of wood from South Africa, and said that it was remarkable that the species should have been introduced there, and then brought back to Great Britain.

Professor E. B. Poulton, F.R.S., exhibited two *Euplœinæ* captured in Fiji by Professor Gilson, and presented by him to the Hope Department. The species, which belonged to the different genera *Nipara* and *Deragena*, bore the closest superficial resemblance to each other, affording an interesting example of Müllerian or Synaposematic likeness. He pointed out that the resemblance depended largely upon the lengthening inwards of a single conspicuous spot in an outer series, so

that it approximated towards the position of a single equally conspicuous spot in an inner series of the other species.

Professor Poulton also exhibited several specimens of *Smerinthus populi* which had been exposed during the pupal stage to the intense heat of July 1900. In consequence of this "forcing" the moths emerged towards the end of that month, and were markedly different in colour from the normal, being much paler in tint with less distinct markings, and the red of the hind-wings of a very different shade. They were also smaller, but this effect may have followed from the larvæ having been brought up under artificial conditions in the Oxford Museum. The moths were derived from the eggs of a single female which was brought to the Hope Department early in June 1900, so that all the immature stages had been completed and the final form attained in considerably under two months.

The Rev. A. E. Eaton exhibited drawings illustrating the wing of *Pampterinus latipennis*, Etn. MS., a remarkable Dipterous fly of the Family *Psychodidæ*, from New Guinea, in the collection of the Hungarian National Museum, Budapest. This wing is oblong-ovate in form and of extraordinary breadth, being considerably dilated in the areas posterior to the postical vein, and still more so in the marginal area, which is the broadest of all. The submarginal area at the costa is slightly wider than the full span of the radial fork, and each of them is wider than any of the remaining areas that have not been mentioned above. The short mediastinal vein near its ending in the subcosta is joined by a perpendicular cross-vein to the subcosta, where the wing (deeply concave thereabouts) is crossed by a crease. The axils of the radial and pobrachial forks are nearer to the cross-veins than in *Pericoma fusca* (sketches exhibited), the type of species to which the New Guinea fly has most affinity. Both surfaces of the wing are clothed with minute truncate obovate-cuneate imbricated scales inserted in the membrane, as well as in the veins.

*Papers, etc.*

Professor Lewis Compton Miall, F.R.S., contributed a paper entitled, "On a new cricket of aquatic habits found in Fiji by Professor Gustave Gilson."

Mr. R. McLachlan said that this was not the first time an *Orthopteron* of aquatic habits had been noticed. Mr. Pascoe had brought back one such insect from the Amazons, which leaped on the leaves of aquatic plants, and there was a recent record of another species with kindred habits being found in Java.

Prof. E. B. Poulton remarked that Prof. Miall was interested in insects which skate upon the water, but there were also some Orthoptera which were aquatic in another sense. Mr. Annandale had brought back from the Malay region an aquatic insect of this order (a *Blatta*) which was far too heavy to skim upon the surface.

The President added that there were some Coleoptera which, although non-aquatic, were so specialized as to be able to use their limbs in a similar manner to water-beetles.

Dr. T. A. Chapman, M.D., F.Z.S., communicated a paper on "Asymmetry in the Males of Hemarine and other Sphinges."

Mr. E. Meyrick, B.A., F.Z.S., communicated a paper on "Lepidoptera from the Chatham Islands."

## June 4th, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of a Fellow.*

Mr. Stanley W. Kemp, of 80, Oxford Gardens, Notting Hill, W., was elected a Fellow of the Society.

*Exhibitions.*

Mr. H. W. Shepheard-Walwyn exhibited a recently emerged male specimen of *Lampides bæticus* taken at Winchester in September 1899, and two varieties of *Lycæna icarus*. Mr. Rowland-Brown said that the insect was reported to have been generally common that year in the Channel Islands, but that those observed and taken were almost entirely confined to the male sex.

Mr. C. P. Pickett exhibited one asymmetrical male and two

females of *Dilina tiliæ*, and a series of the same insect showing great variation of colour and marking, bred during May 1902.

Mr. F. Merrifield showed enlarged photographs of larvæ of *Hygrochroa syringaria*. The larva is usually represented in an attitude in which it is practically never seen, crawling in an elongated form with its pair of long fleshy dorsal tubercles conspicuously projecting. But its habit is not to crawl except in the dark, when it cannot be seen. All day it clings to the edge of a leaf or to a twig in the singular attitude photographed, and is then about as unlike a caterpillar good for a bird to eat as anything can well be, presenting a quadrangular form, something like a square hassock, with tassels at the corners and in one or two other places; the body is bent so as to form four right angles, the head and the anal segments forming two of the tassels, and the rest of the body forming a square from which the pair of long tubercles projects at one corner, the other dorsal tubercles making other projections. Usually the parts of the body are so closely appressed that no daylight is visible between them, even when seen broadside against the light, which can rarely happen in nature. Usually it also gives its body a twist, presenting the fantastic forms shown in two of the illustrations. It is then like a curled-up tip or end of a leaf damaged by frost or in some other way. The resting attitude, unlike that of the Selenias, is practically the same in all stages of growth, and at all ages it is especially addicted to hanging down a few inches suspended by a silken thread, still preserving the hunched-up quadrangular form. Compared with the very dissimilar but equally misleading attitudes of other larvæ — such as the rigid *Amphidasis betularia* or the thorn-like Selenia —it seems an interesting illustration of the very different forms of disguise by which the result of escape from danger is attained. Mr. Merrifield also showed photographs of the dark brown bronzy pupa of this species, in its hammock of open network of silk, very slight but exceedingly strong, from the bottom of which the larval skin is projected, not shortened and compressed, but pushed through the network, and hanging down like a long tail, so as apparently to attain the same end

as in the larval stages, the disguising of its real nature; it looks very unlike an ordinary pupa.

Professor E. B. Poulton, F.R.S., exhibited a lantern slide showing the perfect protective resemblance of *Hybernia leucophearia* to the oak trunk upon which it rested.

Mr. A. Bacot exhibited hybrid larvæ resulting from a pairing between a male *Malacosoma neustria* and a female *M. castrensis*, also larvæ of *M. neustria* and reputed larvæ of *M. franconica* for comparison. He said that this year's brood of hybrid larvæ had separated into two batches, the "Forwards" being now nearly full fed, and from one and a half to two and a half inches in length. The "Laggards" were not yet half-grown, being only half to three-quarters of an inch long, in this respect exactly following last year's brood resulting from a similar cross, in which case the "Forwards" produced only female specimens, while the "Laggards" produced only males.

*Papers, etc.*

Mr. H. J. Elwes, F.R.S., read a paper on "The Butterflies of Chile," and exhibited a selection of the specimens he had taken during December, January and February in that country. He pointed out that the number of species of butterflies found in Chile was extremely small considering the large area, varied physical and meteorological conditions, and rich flora of the country. He accounted for this by the fact that the climate and condition of the land areas bordering Chile had prevented the immigration of neotropical species from the north. He described briefly the great difference in the rainfall of the country south of Conception, which causes South Chile to be almost entirely a forest country, whilst Central and North Chile is so arid that cultivation is carried on almost entirely by irrigation. The endemic species of Satyridæ and Hesperidæ constituted about two-thirds of the whole butterfly fauna, Nymphalidæ and Lycænidæ being very few in numbers. Some butterflies of Holarctic types, such as *Colias vautieri*, had an extremely wide range and extended with little variation right down to the Straits of Magellan. Among the most remarkable species which he showed was the unique Satyrid, *Argyrophorus argenteus*, the upper side of which is of a brilliant metallic

silver colour, nothing similar existing in the whole family. This flies on open grassy hillsides, whilst in the forests close by, a Hesperid, *Cyclopides pselma*, has its wings on the underside entirely of a metallic golden colour, this also being unique among the Hesperidæ. It seemed impossible to account for such remarkable cases of coloration by any theory of protective colouring. No natural frontier appeared to exist between Chile and Argentina, and nearly all the mountain species occurred on both sides of the political frontier, there being little difference between the alpine and the low country species.

The PRESIDENT remarked that the Chilean Coleoptera generally resembled those of the Holarctic region. Mr. ROLAND TRIMEN, F.R.S., said that in the eastern hemisphere the west sides of the great continents stretching south were poor in their fauna and flora. For instance, this was the case in South Africa on the west, and in South Australia it was even more remarkably so than in Chile. In South Africa this was attributed to the cold antarctic currents that sweep up to the north along the coast.

Mr. S. L. HINDE read a paper, illustrated by lantern slides, upon "The Protective Resemblance to flowers borne by an African Homopterous insect, *Flata nigrocincta*, Walker." He said that "the cluster of insects grouped to resemble a flower spike," which forms the frontispiece of Professor J. W. Gregory's "Great Rift Valley," had attracted some criticism, and that as he was familiar with the insect figured, and with its larva, in a wild state, it seemed desirable to publish the evidence. In the plate the insects are collected on the vertical stem, the green individuals uppermost considerably smaller than the red beneath, like the unopened green buds towards the top of a flowering spike as compared with the expanded blossoms below. The separate representations of the green and red forms, however, indicate no difference in size, and experience confirms this conclusion, so that the impression conveyed by the frontispiece plate is erroneous. After further noting that the uniform deep pink colour of the exposed parts of the insects figured was also incorrect, Mr. HINDE remarked that he had never seen the insects grouped according to their colours,

but invariably mixed, that he had never found larvæ and imagines on the same stem or even together on the same tree or bush, nor did the imagines affect vertical stems, but always those actually or approximately horizontal. It does not by any means follow that Professor Gregory was mistaken in his impressions, but it is certain that conditions are common other than those recorded by him. On comparison of material with Professor Gregory's in the British Museum of Natural History, Professor Poulton had come to the conclusion that both sets of specimens certainly belong to the same species, viz. a form slightly different from *Flata nigrocincta*, Walker, but evidently closely allied and perhaps specifically identical with it. Continuing, Mr. Hinde said that, "when disturbed the imagines fly, and the larvæ hop, a short distance in any direction, but soon collect into groups again. The larvæ toward the end of a growing branch are the smallest, and this arrangement may possibly reconcile Professor Gregory's account with ours."

Professor E. B. Poulton suggested that if the larvæ at the top of the stem were younger, and those lower down older, it was conceivable that the mature forms varied in colour accordingly. Mr. Guy Marshall said that a unicolorous species of *Flata* occurred in Mashonaland, which congregates on vertical stems and exudes a large amount of wax. He was not able to distinguish the larval from the pupal form. Sir George Hampson said the insects figured were orange when first brought home, and that the pink-winged imago was an error of the colourist. Mr. Colbran Wainwright remarked that in the case of British Homopterous insects the imagines very rarely faced different ways on the stem, while the heads of the larvæ were always in one direction.

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## October 1st, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Exhibitions.*

Mr. H. St. J. Donisthorpe exhibited specimens of *Dibolia cynoglossi*, a beetle which has not been recorded as British since 1866.

Mr. O. E. Janson exhibited a fine hermaphrodite specimen of *Argynnis paphia* taken in the New Forest by Mr. Herbert Charles on July 28th, and recorded in *The Entomologist*: also a melanic specimen of *Papilio demoleus* from Ceylon in which all the usual marginal and submarginal yellow markings were absent and the discal markings much obscured; on the underside the yellow markings were entirely wanting.

Mr. C. P. Pickett exhibited a ♂ *Callimorpha dominula* with the hind-wings suffused with black, and an extra black spot in the centre, the white spot on the fore-wings being absent; and a very large ♀ of the same species, bred from larvæ found at Walmer at the end of March; also three aberrant specimens of *Agrotis fimbria* bred from larvæ taken at Wood Street during the same month.

Mr. C. O. Waterhouse exhibited specimens of a wasp, *Zethus chalybeus*, and a neuropteron, *Mantispa semihyalina*, received with a collection of Hymenoptera from Rio Janeiro suggesting a curious case of mimicry.

Mr. F. B. Jennings exhibited specimens of *Hister merdarius* from Broxbourne, Herts, part of a large colony of this usually scarce species found with *Hister 12-striatus* and other beetles inhabiting a heap of a chemical substance, probably gas-lime, in which also many larvæ, presumably of *Hister merdarius*, and burrows were observed. The soil was warm and moist, and this, and the presence of a quantity of vegetable refuse thrown on the heap, was no doubt the attraction to the Histers to settle there.

Mr. A. J. Chitty exhibited a portion of the nest of *Vespa vulgaris* containing a specimen of *Metœcus paradoxus*, which had died just before emerging from the cell in which it had grown. He pointed out that the insect kept its thorax at the orifice of the cell, the head being tucked in, and that the thorax was coloured yellow at the sides and black down the middle, somewhat resembling the face of *Vespa vulgaris*.

A discussion followed, in which Professor Poulton, Mr. Waterhouse, Dr. Chapman, and Mr. Chitty took part.

Mr. H. Rowland-Brown exhibited on behalf of Mr. G. F. Leigh of Durban, a ♀ and ♂ specimen of a rare Noctuid, *Musgravia leighi*, Hampson, discovered by him in Natal, and

read the following remarks upon the life-history of the species, communicated by the captor:—

"The eggs are laid by the female on the twigs of a mistletoe that grows upon various trees at Durban, and are brown in colour and nearly round; the larvæ emerge, about twenty-one or twenty-four days afterwards, and feed gregariously, by night only, upon the underside of the thick leaves. In the very young stage they congregate together round the twigs during the day; they are nearly black in colour, slightly hairy, and with the heads black. After the first moult, which takes place in about five or six days, they are dark brown in colour, slightly hairy, and at night very active indeed, and measure slightly under half-an-inch. They still, however, feed in company upon the underside of the leaves only. (I may mention that the leaves of their food are very thick and hard.) About five days later they cast their skins for the second time, when they are about five-eighths of an inch in length, and vary in colour a good deal, some being nearly black, some dark brown, others light brown, and in some cases nearly grey in colour, and variegated down the back very similar in this respect to our *Catacola promissa;* the head is black with a number of small hairs upon it, the legs black and claspers brown, or sometimes grey; they are slightly humped on the last segment, and the hind claspers are larger than the others; during the day they congregate upon the branches and trunk of the tree upon which their food grows, lying perfectly still against the bark, always choosing the bark that most resembles their colour, and even although as many as twenty-five to thirty are in a patch, they are very difficult to find. They go up after dark to their food, which they now eat right through, but still feeding in company, seven or eight on every leaf, of which nothing is left except the small thick stem. After the next moult they are about one inch to one and a quarter inches in length, and differ very little in appearance from that of their previous stage except that the second and third segments are much larger than the others, and the hump on the last segment too; they are now beautifully variegated down the back, and the underside between the claspers is yellow and sometimes white in colour with black spots; they are most active by night and eat

very quickly, making up for their long fast by day. They can sometimes be found during the day right down close to the ground upon the bark, or in any large crevice in the trunk of the tree often twenty to forty feet from their food. It was whilst sugaring some two years ago that I first found these larvæ, and they were then crawling up the tree from the ground. I could have taken forty or fifty if I liked, but not knowing they were rare at the time, I only took thirteen, from which I reared nine moths. After their next moult they are about one and a half inches in length, and feed up very quickly indeed, returning each day to almost the same position upon the trunk of the tree; the head is black with white or grey markings, the second, third and fourth segments are larger than the others, and the last segment very humped; they are beautifully variegated down the back with grey, yellow, red-brown, and often—if there is much lichen upon the trunk of the trees—suffused with green; from the head to the hind claspers above the legs and claspers are long tufts of hairs light and dark brown in colour, the hind claspers are much larger than the others, and they sprawl out a long way behind. The underside is now generally yellow with black spots, sometimes being grey or white. When full fed they are about two and a quarter inches in length, and they go up at night and spin a loose cocoon, white in colour, in the leaves, and change to light grey pupæ, covered with black-brown hairs, very similar to *Liparis monacha*, emerging about ten days afterwards. The male is much smaller than the female, and both are nearly black in colour. Owing to the food-plant being uncommon the moth is certainly rare, and I have never taken or found the same in a wild state, nor has any one else I know done so. Yet it is undoubtedly double-brooded, as I have reared a good number from ova obtained from a pairing of moths bred from larvæ found in November 1901. The moths emerged in December, the first coming out curiously enough on Christmas Day, and those I bred from the pairing then obtained came out in March 1902. I did not, however, get a pairing on this latter occasion, although I sacrificed two females and five males to do so. I have searched this food upon every occasion when met with this year, but have not again found the larvæ. This mistletoe, however, is

the food-plant of the butterfly *Mylothris agathina*, and curiously enough the larvæ of this in habits exactly resemble those of *Musgravia leighi*, congregating together upon the trunks of the trees by day and feeding by night."

Mr. Stanley W. Kemp exhibited two additions to the British list of Coleoptera, *Bembidium argenteolum*, from Lough Neagh, Armagh, and *Læmostenus complanatus* from the neighbourhood of Dublin, taken in June 1902.

Mr. W. J. Kaye exhibited examples of *Heliconius lindigii*, *Heliconius antiochus*, and *Morpho achilles* from British Guiana with notches taken out of the hind-wings, presumably by birds, to illustrate that these distasteful or warning-coloured species are subject to attack, thus helping to show that experimental tasting as propounded by the Müllerian theory of mimicry does exist and go on.

*Papers, etc.*

Professor L. C. Miall, F.R.S., communicated a Paper by Mr. T. H. Taylor, M.A., entitled "The Tracheal System of *Simulium*."

Professor Auguste Forel, M.D., communicated a Paper entitled "Descriptions of some Ants from the Rocky Mountains of Canada (Alberta and British Columbia) collected by Edward Whymper."

Dr. T. A. Chapman, M.D., F.Z.S., read a Paper entitled "On *Heterogynis paradoxa*."

## October 15th, 1902.

Professor Edward B. Poulton, M.A., D.Sc., F.R.S., Vice-President, in the Chair.

*Exhibitions.*

Mr. A. J. Chitty showed an entirely black specimen of *Metoecus paradoxus* as tending to disprove the mimicry suggested by him at the meeting on the 1st October. Dr. Chapman said that in his experience one out of every six specimens of this species was black. Mr. Donisthorpe stated that out of about one hundred specimens he had never caught or bred a black *Metoecus*.

Mr. E. P. Pickett exhibited an aberration of the female of *Argynnis aglaia*, aberrations of *Epinephele jurtina*, a series of fresh *Melanargia galathea* taken at the end of August, aberrations of *Zygæna filipendulæ* and a long series of *Lycæna corydon* taken near Folkestone and Dover in August last, including four males of the last-named species, with the black band on the edge of the fore-wings much deeper than usual; also twelve dwarf male specimens of this species, four dwarf females, and many other aberrant forms.

Mr. Goss said that this dwarf form of *L. corydon* occurred constantly, according to Mr. Sydney Webb, in one valley about two miles east of Dover, but he was unaware of its regular occurrence elsewhere in this country. He remarked that a dwarf form of *L. arion* occurred in nearly all the localities where the type was found, both in Gloucestershire and Cornwall. Professor Poulton, Dr. Chapman, and Mr. Sloper also remarked on this dwarf form of *L. corydon*.

Dr. Chapman exhibited a *Hybocampa* sent to him from Queensland by Mr. F. P. Dodd under the name of *Notodonta dryinopa*, Lower. It was remarkably similar in appearance, structure, and habits to *Hybocampa milhauseri* (see *Entomologist*, 1889, and p. 43 of 1902). He stated that the pupa with a similar spine to that of *H. milhauseri* does not cut out a regular oval lid from the cocoon like that species, but by a stabbing process pierces it with a number of holes, so that a piece is more easily pushed off. The cocoon being covered with bits of bark, stone, etc., a cutting process would be impossible, whereas the cocoon of *H. milhauseri* was of pure gum-like silk. He pointed out that the larva much resembled that of *H. milhauseri*, but the hinder segments were more like those of *Stauropus fagi*. He also exhibited living eggs, larvæ, and imagines of *Orina tristis*, var. *smaragdina*, from Pino, Lago Maggiore. The beetles which were still living were taken on May 30th, and had laid many eggs. Dr. Chapman said that the embryo, ready to hatch, might be seen within some of the eggs, and its hatching spines observed.

Mr. Sloper exhibited a specimen of *Lycæna hylas*, caught at Dover on the 7th September last.

*Papers read.*

Mr. Martin Jacoby read a Paper entitled "A further Contribution to our Knowledge of African Phytophagous Coleoptera."

Mr. Malcolm Burr read the following communication from Hofrath Dr. Carl Brunner Von Wattenwyl, entitled "Observations sur le nom générique *Acrida*."

"Dans le 'Monograph of the genus *Acrida*' (Trans. ent. soc. Lond. 1902, p. 166), un mémoire éminant et par cela classique, Mr. Malcolm Burr dit 'Brunner refuses to accept the name *Acrida*.' Je tiens à motiver ce refus. Il est vrai que Linné s'est servi le premier du nom générique '*Gryllus*' (*Acrida*) pour classer le '*nasutus*' et quelques autres espèces (Mus. Lud. Ulr. p. 118, 1764) sans définition précise du genre. Cette définition, telle qu'est admise aujourd'hui, fut établie par Fabricius (Ent. system. II, p. 26, 1793) sous le nom de *Truxalis* (recte *Tryxalis*).

"Stål, qui a rétabli le nom donné par son illustre compatriote, a confondu les règles qui doivent être appliquées pour les noms des espèces avec celles qui gouvernent les noms des genres.

"L'espèce est une *entité* naturelle et il est juste que le premier nom que l'on emploie pour la désigner, lui reste inhérent pour toujours.

"Par contre le classement de cette entité dans les genres est une action arbitraire des savants et dépend de considérations suggérées par l'étude, la comparaison et le caprice des auteurs. Aussi nous voyons que dans la suite de l'avancement de la litérature la même espèce passe dans bien des genres divers.

"Le nom '*Tryxalis*' a servi pendant près d'un siècle pour désigner un genre bien établi et je considère son changement comme un caprice non motivé et donnant lieu à des confusions. Notre écriture sainte nous a transmis ce nom et j'y attache ma foi."

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## November 5th, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of Fellows.*

Lieutenant T. Delves Broughton, R.E., of Alderney, Channel Islands; Mr. Arthur Percival Buller, of Wellington, New Zealand, and of the Inner Temple, E.C.; the Rev. Canon C. T. Cruttwell, M.A., of Ewelme Rectory, Oxfordshire; Mr. R. S. Hole, of the Rectory, North Tawton, Devon; and Mr. W. E. Sharp, of Ledsham, Shakespeare Road, Hanwell, W., were elected Fellows of the Society.

*Proposed alterations of Bye Laws.*

The Secretary informed the Meeting that a request for certain alterations in the Bye Laws, signed as required by Chapter 21 thereof, having been received by the Council, Mr. Arthur J. Chitty had drafted the necessary amendments. Mr. Chitty then read the proposed amendments and explained the course to be taken to carry them into effect.

*Exhibitions.*

Mr. H. J. Elwes, F.R.S., exhibited, on behalf of Mrs. Mary de la Béche Nicholl, a collection of Butterflies made by her in February, March, and April, 1902, in Southern Algeria; also a collection of Butterflies afterwards made by her in the Picos de Europa in Spain; the latter collection comprised about 85 species and was made in 25 days. Mr. Elwes remarked that these collections contained several interesting species of Erebia, Lycæna, and other genera, and included three species, from Algeria, not at present represented in the British Museum Collection.

The Butterflies taken by Mrs. Nicholl in the Picos de Europa included the following:—*Parnassius apollo*, *Aporia crataegi*, *Pieris brassicæ*, *P. napi* var. *napææ*, *P. rapæ*, *Leptidia sinapis*, *Colias edusa*, *C. hyale*, *C. phicomone*, *Gonepteryx rhamni*, *G. cleopatra* (Atlantic watershed), *Pyrameis atalanta*, *P. cardui*, *Vanessa io*, *V. urticæ*, *Melitæa aurinia*, *M. phœbe*, *M. didyma*, *M. athalia*, *Aphantopus hyperanthus*, *E. jurtina*, *E. tithonus*, *Cœnonympha leander*, *C.*

*arcania*, *C. pamphilus*, *C. dorus*, *Laeosopis roboris*, *Thecla ilicis*, *T. spini*, *Chrysophanus virgaureæ*, *C. phlæas*, *C. hippothoë*, *C. gordius*, *C. dorilis*, *Lampides telicanus*, *L. bœticus*, *Lycæna argiades*, *L.argus*, *L. bellargus*, *L. astrarche*, *L. corydon*, *L. hylas*, *L. icarus*, *L. orbitulus* var. *pyrenaica*, *L. minimus*, *Cyaniris argiolus*, *M. parthenie* var. *varia*, *M. aurelia*, *Argynnis pales*, *A. hecate*, *A. lathonia*, *A. dia*, *A. daphne*, *A. aglaia*, *A. adippe* var. *cleodoxa*, *A. paphia*, *Melanargia galathea*, *Erebia epiphron* var. *pyrenaica*, *E. stygne*, *E. evias*, *E. gorge*, *E. lefebvrei* var. *astur*, *E. tyndarus*, *E. euryale*, *Satyrus alcyone*, *S. semele*, *Pararge egeria*, *P. mœra*, *P. megæra*, *Hesperia carthami*, *H. serratulæ*, *H. sao*, *H. sylvanus*, *H. thaumas*, *H. actæon*, and *Thanaos tages*.

Dr. T. A. Chapman exhibited, and made remarks on, two Butterflies taken last July at Bejar, in West Central Spain, both notable as being very decidedly larger than any forms of the same species recorded from any other locality. He stated that one of them belonged to a form of *Lycæna argus* (the *L. ægon* of the British list). They were taken about one and a half miles east or south-east of Bejar on July 9th and following days. In size they average about 33·0 m.m. ♂ ♂ and 32·0 m.m. ♀ ♀. Some large specimens are 35 m.m. Two dwarf specimens (the smallest out of 100 taken) being 26 m.m. and 29 m.m. respectively. These compare with specimens from Tragacete last year 30 m.m., Carinthia 29, Locarno 25, a dwarf from Pontresina 18 m.m. (specimens exhibited, as well as of *L. argyrognomon* for comparison).

The expanses given by various authors are—

| | | | |
|---|---|---|---|
| Lang | ·9 to 1·1 inches | = | 22–26 m.m. |
| Kane | ·9 ,, 1·0 ,, | = | 22–25 m.m. |
| Barrett | 1 ,, 1¼ ,, | = | 25–31 m.m. |
| Meyrick | | | 25–30 m.m. |
| Ruhl | | | 23–28 m.m. |

This form may be called var. *bejarensis* characterised by its large size 33–35 m.m., by the definiteness of the black spots on the hind margin, often surrounded with a whitish suffusion, by the broadening of the black nerve rays towards the dark border.

The ♀ usually has the orange marks upper side right round

all wings. And their horse-shoe form on the hind wings is often completed into a circle by a white or bluish line. In some specimens they are reduced to one or two on the hind wing only. The blue of hind wing of ♂ is often restricted as in typical *argus*, but oftener advances up to vein 7. The var. *hypochiona* is perhaps the nearest to this form. It goes a good way to bridging over the differences between *argus*, *lycidas* and *zephyrus*, and in some degree *argyrognomon* (*argus*, Esp.) also. It resembles the latter in the extension of the blue of the hind wing of the ♂ and in the completed ocelli of the ♀ hind wing; but the colour of the underside and of the fringes of the ♀ are characteristic of *argus*, apart from the wide border and other obvious characters. The other butterfly is a form of *Erebia stygne*. This differs from the type chiefly in size, having an expanse of 51 m.m. ♂ and 55 m.m. ♀, comparable with rather large specimens (exhibited) from the Alps measuring 44 ♂ and 45 ♀, and the measurements given by Ruhl 38–42 m.m., Kane 1·25–1·60 in. = 31–40 m.m., Lang 1·20–1·60 in. = 30–40 m.m. They are characterised by having the "rusty band" very large, bright and well defined. The males usually have four, often five spots on upper wings, and the females almost always five pupilled spots, but occasionally with a sixth. The underside of the hind wing of the males is very deep black, and of both sexes the ground colour is black, and the broad rusty band extends a good deal nearer the base than in typical *stygne*. *Stygne* is a wide-spread species, but I do not know that it has previously been recorded from Spain. The var. *pyrenaica* seems to hail from the French slope of the Pyrenees, and is a variety with the rusty bands and eyespots reduced, instead of increased as in the form before us. I propose to name this form var. *bejarensis* from its habitat, the Sierra de Bejar, where it flies on a slope amidst *Cytisus pergans*, at a height of about 5000 to 5500 feet, during the first half of July. This might easily have been described as a distinct species, in the good old times, when the wing markings so protean in this genus were relied on. The less variable ♂ appendages, however, show it to be really *stygne*. Staudinger's last edition by the way still sticks to these good old ideas and makes *lefebvrei* a var. of

*melas*, and places the species before us a long way from *goante*, its nearest ally, because it used on the ground of size to be placed with *æme* and *medusa* close after the grass Erebias. The large size of var. *bejarensis* may assist to remove it from this position. The ♂ clasp as compared with Swiss stygne is 2·6 m.m. long as compared with 2·3 m.m., the increased length being chiefly in the shaft, and the marginal spines or styles somewhat less depressed.

Mr. R. South exhibited four specimens of a large form of *Cupido minima* (*Lycæna minimus*) from Cumberland, sent to the Natural History Museum by Mr. Mousley of Buxton. Except that they are slightly smaller in expanse they approach very closely to var. *alsoides*, Gerhard, as represented by a series of Swiss examples in the Museum collection, among which are specimens named by Zeller. He said that it might be remembered that Mr. B. Piffard, of Brockenhurst, Hants, recently presented two examples of the *alsoides* form of *C. minima* to the Museum collection of British lepidoptera. Those specimens, which were stated to have been captured on the coast near Lymington, are rather larger than the Cumberland specimens now exhibited and agree in size with most of the *alsoides* in the Museum series. He also exhibited on behalf of Mr. J. H. Fowler, of Ringwood, Hants, a series of *Lithosia deplana*, Esp., from the New Forest, showing interesting variations in both sexes, but more especially in the females. Two of the latter agree with Hübner's *ochreola*; three others have the fore wings orange-buff, and the hind wings pale buff slightly tinged with fuscous; these specimens except for their larger size and broader wings might easily be confused with *L. sororcula*, Hufn. A sixth specimen represents a connecting link between the two extreme forms. It was stated that Mr. Eustace R. Bankes had recently recorded somewhat similar aberrations of *L. deplana* from the Isle of Purbeck, and that Mr. Fowler had not observed either var. *ochreola* or the orange-buff form prior to 1901. Mr. South also exhibited examples of a local race of *Zonosoma* (*Ephyra*) *pendularia* occurring in N. Staffordshire, taken by Mr. F. C. Woodforde, of Market Drayton, and stated that the name *subroseata* had been proposed for this form. He also exhibited

a dark aberration of *Pyralis lienigialis*, Zell., taken in a village about 12 miles N.E. of Oxford, Aug. 22, 1902, by Mr. Theodore H. Robinson, of Boscombe, Hants. It was stated that in 1879 and 1880 the species occurred at Stoney Stratford, Bucks.

Mr. Hamilton Druce exhibited a specimen of *Limenitis populi*, L., caught whilst being chased by a small bird in July 1901, near Riga, Russia; also a specimen of *Nesamia nonagrioides*, Lefeb., bred from a larva found feeding in the interior of a banana.

Mr. J. H. Carpenter exhibited a gynandromorphous specimen of *Lycæna icarus*, having the coloration of the male on the left side and that of the female on the right side, captured on Raunmore Common, Surrey, in June last; also several aberrations of this species from Raunmore Common and the Isle of Wight. He also showed specimens of *Vanessa antiopa*, bred from German larvæ, including a remarkable aberration in which the usual blue spots on the upper wings were entirely absent.

Mr. H. St. J. Donisthorpe exhibited a foreign specimen of *Quedius suturalis*, lent him by Mr. Keys of Plymouth, and a British specimen taken by himself at Gravesend in 1891; also for comparison a specimen of *Quedius obliteratus* taken at Plymouth. He said that most of the specimens of, so called, *Quedius suturalis* in British collections were really *Q. obliteratus*.

Mr. C. P. Pickett exhibited a remarkable series of *Angerona prunaria*, the result of four years' inter-breeding between dark males from Raindean Wood, near Folkestone, and light-coloured females from Epping Forest; also unicolorous light orange yellow males, light yellow females, dark orange males sprinkled with black, and other unusual aberrations.

Professor E. B. Poulton, F.R.S., exhibited a series of lantern slides prepared from negatives taken by his assistant Mr. A. H. Hamm, of the Hope Department, and Mr. Alfred Robinson, of the Oxford University Museum. The slides represented a series of the larvæ and imagines of British moths photographed under natural conditions. Mr. Hamm's photographs of moths clearly showed the attitude of the insect in relation to the background

which it had selected. Some of the species were shown upon their normal background of the bark of various kinds of trees, others upon lichen-covered stone walls. Mr. Robinson's photographs similarly represented the larvæ of species of British moths in their natural attitudes upon the food-plants.

Professor Poulton also showed a representation of the pupa of *Limenitis populi* prepared from Portschinski's figure and description, and explained the highly ingenious hypothesis by which the appearances are accounted for by the Russian naturalist. The dorsal hump so well known in pupæ of this genus takes in *L. populi* the form of a hemispherical translucent drop-like convexity which was mistaken for a drop of honey by Portschinski's friends. This he believes represents a drop of blood which has been forced out of the pupa as the result of an injury caused by some enemy. The adjacent part of the pupa is laterally compressed and marked with lines which suggest that the chitinous cuticle is transversed by cracks, while the contour of the segments in immediate proximity to the convexity is such as to convey the impression that they have yielded to the pressure which caused the blood to escape. Below the point of apparent injury the pupa is covered with a varnish-like coating which makes it appear wet, while above the coating is wanting and it appears to be dry. The pupa is fixed to the upper surface of one of the outer leaves of the poplar so as to be very conspicuous, while the leaf is attached to the branch by silken threads, so that it could not fall even if its stalk were to become detached. The Russian naturalist found that the pupa was refused by turkeys, and he believes that it is distasteful and that its warning (aposematic) characters take the remarkable form of an apparent injury, which suggests that it has been attacked and abandoned as unpalatable by some earlier enemy.

*Papers.*

Mr. C. O. Waterhouse communicated a Paper by Mr. L. R. Crawshay entitled "On the Life History of *Drilus flavescens*, Rossi."

## November 19th, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of a Fellow.*

Mr. E. M. Cheeseman, of 63 Railway Street, Durban, Natal, was elected a Fellow of the Society.

*Proposed alterations of Bye Laws.*

The proposed alterations of the Bye Laws were read a second time and some discussion followed.

*Exhibitions.*

Dr. Sharp, F.R.S., exhibited the egg-cases made by a beetle of the genus Aspidomorpha (*A. punctivosta*) and stated that they had been sent to him by Mr. F. Muir, of Durban, Natal, where the beetle and the egg-cases are common. He said that Mr. Muir had observed the manner in which the case is formed, and hoped shortly to present a paper to the Society describing this, and the anatomical structures involved.

Dr. Norman H. Joy exhibited a well-marked aberration of a female *Lycæna icarus* striped black on the underside in the place of the usual ocellations; an androgynous specimen of the same species; an aberration of a male *Lycæna bellargus*, also striped on the underside; a specimen of *Lycæna* (*Everes*) *argiades* taken in 1885 near Bournemouth; and specimens of *Apatura iris* from the neighbourhood of Reading, captured in 1901. With regard to the latter species he said that with Mr. Lee he took altogether fourteen specimens, all males, eleven of them from the three top branches on the north side of a beech tree. No females were seen; in fact it appeared to be the throne of the ruling "Emperor" of the wood. Whenever another *iris* came by, the one on the "throne" attacked it, and after a fight in which one would eventually pursue the other out of sight, the conqueror would return to the perch. If this was captured the next *iris* coming

along would take possession of the throne and so on ; so that five were taken in one afternoon off the same tree. When on the throne they were extraordinarily confident, as more than once the chosen branch was struck hard without disturbing them. Yet if one happened to settle on a lower branch the slightest movement even of the hand frightened it away at once.

Mr. Claude Morley exhibited the specimen of *Diastictus vulneratus*, Sturm., first recorded in Great Britain in the current number of the Entomologists' Monthly Magazine, and a rare blue form of *Phratora vitellinæ*, taken on low herbs, from Tuddenham Fen, Suffolk.

Mr. G. C. Champion exhibited specimens of *Nanophyges durieuri*, Lucas, a beetle from Central Spain, with drawings of the larva, pupa and perfect insect.

Professor E. B. Poulton, F.R.S., stated that Mr. A. H. Church, M.A., of Jesus College, Oxford, had observed the larvæ of a species of *Cucullia* (probably *C. verbasci*), feeding upon *Buddleia globosa* which was growing against a wall in the Oxford Botanical Gardens. Mr. Church had sent shoots of the same plant to a friend at Warwick, and these when grown in a similar position in his garden, were all attacked by the same species during the past summer (1902). There were three of these plants growing about ten yards apart, each about five feet high, surrounded by roses, and very inconspicuous. It is possible that the eggs are laid upon the *Buddleia* because of the very rough general resemblance in certain respects between its leaves and those of *Verbascum*, in the same manner, as the speaker suggested in 1887, that the common food-plants of *Smerinthus ocellata*, viz. apple and sallow, may be explained by the parent moth having mistaken the one for the other (Trans. Ent. Soc. Lond., 1887, p. 314). In Section 11 of the memoir cited it is shown that many young larvæ, on emergence from the egg, are able to feed upon strange species of plants, which, later they would refuse, if they had become specialized to one of the recognized food-plants.

Mr. R. McLachlan, F.R.S., said that no doubt the first food-plant of the young larva was an important factor.

*Mamestra persicariæ*, a pest in his garden at Lewisham, as a rule attacked first and most *Anemone japonica*. He had this year offered them fern and elder (which is reputed a favourite food), but the larvæ which had been found upon the anemone refused to touch either of the plants.

Mr. H. Goss stated that in August 1898 and 1899, he collected numbers of the larvæ of *Chærocampa elpenor* feeding on *Impatiens fulva*, a North American species of Balsam which has become naturalized in abundance on the Weybridge Canal, and on some parts of the Thames. When the Balsam was exhausted he supplied the larvæ with the usual food-plant of the species, the Common Willow Herb (*Epilobium hirsutum*) because it was easily obtainable close at hand. He also offered the larvæ Fuchsia, *Galium mollugo* and *G. aparine*. The larvæ refused to eat any of these plants, and nearly three dozen died of starvation before a fresh supply of the Balsam could be obtained from Byfleet or Weybridge.

Professor Poulton expressed his opinion that unusual food-plants must be commonly begun from the egg, and as a further example quoted from Trans. Ent. Soc., 1887, p. 313, the case of *Phalera bucephala*, which, found half grown upon hazel, refused to touch elm and *Salix triandra*, there being with this as with other species evidently some sort of gastric association between the larva and its food-plant.

Professor E. B. Poulton, read the following communication from Mr. G. F. Leigh, of Durban, Natal.

"I have perused with great interest the abstract of the paper read by you entitled 'Five Years' (1897–1901) Observations and Experiments on the Bionomics of South African Insects,' etc., in the Proceedings of the Entomological Society of London for this year, and as I see no special mention of one great enemy to insects here, perhaps it may be of interest to give you particulars of the same. I refer to the ordinary and very common grey South African rat, which is one of the most dreadful pests to breeders of butterflies and moths that I know of. These rats seem to be particularly fond of almost any pupæ, and I have had thick wooden boxes containing pupæ eaten right through, and the contents all devoured. They are especially fond of *Chærocampa cson* and *C. nerii*.

Even more remarkable than their keenness in hunting pupæ is the way in which they capture moths on the wing whilst feeding. Over the verandah of my previous residence here I had a large honeysuckle upon the blossoms of which a great number of Sphingidæ used to feed. Whilst I have been watching them just at dusk all of a sudden I have heard a rush, and down came a rat from the roof right on to the plant, and more often than not the moth selected for attack was captured, usually followed by a fight amongst the rats over the prize.

"The moths I have seen caught in this way are *Sphinx convolvuli*, *Nephele variegata*, *Chærocampa eson* and *C. celerio*. The first-named is the most successful in escaping, owing to the long proboscis which compels it to hover at some distance from the blossom. *N. variegata* is probably the swiftest flier, but is more conspicuous owing to its dark colour.

"Bats are also very destructive of South African insect-life. I have often seen them swoop down and take both moths and beetles on the wing. *Charaxes ethalion* also has a terrible enemy in the larval state in the shape of a small Mantis larva. This butterfly instead of being rather rare would be one of our commonest species, as the ova and young larvæ can be found by hundreds in April on certain small trees. After leaving them to grow in the natural state upon their food-plant, I was surprised in the season of 1901 to find only single larvæ here and there where there had been great numbers of both ova and young larvæ. This season I determined to find out the reason, and marked down several young trees with hundreds of eggs upon them. After they had hatched I watched every day and found them getting less and less numerous, so I paid a visit by night with a lantern and then found the cause. On all the trees were several larvæ of a Mantis eating the young *C. ethalion* larvæ for all they were worth. This winter I have planted small trees in my garden, and hope to breed *C. ethalion* next year by protecting it in 'sleeves.' I may also mention that *C. ethalion* is badly ichneumoned in the ova state."

## December 3rd, 1902.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

*Election of Fellows.*

Mr. Philip J. Barraud, Bushey Heath, Herts., Mr. William E. Butler, Hayling House, Oxford Road, Reading, and Dr. Malcolm Cameron, R.N., H.M.S. Harrier, Mediterranean Station, were elected Fellows of the Society.

*Proposed alterations of Bye Laws.*

The proposed alterations of the Bye Laws were read a third time.

*Exhibitions.*

Mr. H. W. Andrews exhibited a male specimen of *Therioplectes luridus*, from Chattenden, July 1902. Females of this species have been taken by Colonel Yerbury, as reported in the Proceedings (1900, p. xiv), at Nethy Bridge, N.B., but there appears to be no record of the capture of the male. He also exhibited a male *Platychirus sticticus*, and a female *Microdon devius* from Eltham, and Shoreham (Kent), respectively, and three small dark examples of *Syrphus balteatus*, taken near Brockenhurst, where the form was not uncommon, in October 1902.

Mr. M. Burr exhibited two species of *Phyllium* from Ceylon, sent by Mr. Green, *P. bioculatum*, Gray (= *crurifolium*, Hann., and *scythe*, Gray), which produces flanged ova, and is the commoner of the two, and *P. athanysus*, Westw., a scarce species with a less ornate ovum. Both specimens were very fresh adult females.

Mr. R. Adkin exhibited a hybrid *Selenia bilunaria* × *S. tetralunaria*, together with spring and summer examples of both species for comparison. From a pairing which took place between a wild ♂ *bilunaria* and a ♀ *tetralunaria* reared in captivity, about sixty ova were obtained, about half of which hatched. The larvæ appeared to be sickly, and in the result only three imagines were reared, all males, which emerged

between July 30th and August 2nd. The hybrid presented some of the markings of each of its parents, the cresentic blotch at the apex of the fore-wings, and the band on the hind-wings closely following *tetralunaria*, but no trace of the dark spot usually so distinct on each of the wings of that species, especially in the summer emergence, was visible, while the "second line" of the fore-wings closely followed *bilunaria*. In colour it more nearly resembled that of the summer brood of *tetralunaria*.

Mr. A. J. Chitty exhibited a number of insects, taken, between September 22nd and October 7th last, from a decayed fence or hedge made of different kinds of wood, with the bark left on. The uprights of the hedge were chiefly of birch. The exhibit comprised about a hundred species, of which seventy-nine or eighty were Coleoptera. Four species of beetles, viz. two species of *Pogonocherus*, the scarce *Microcephalus albinus*, and the extremely rare *Tropideres niveirostris*, mimicked the surroundings of lichen-covered bark, and one, *Acalles turbatus*, resembled buds. Of the rest, there were five species of *Dromius*, *Anisoxya fuscula*, Ill., *Orchesia minor*, *Clinocara tetramera*, Thoms., and *Tetratoma ancora*.

A discussion followed, in which the President, Professor E. B. Poulton, and others took part.

The meeting was then adjourned, and subsequently resolved itself into a Special General Meeting in accordance with the terms of the notice given under Chap. xviii. § 1, of the Bye Laws.

*Special General Meeting.*

A written notice to alter and amend certain of the Bye Laws of the Society, signed by Canon W. W. Fowler, Mr. H. Goss, Professor E. B. Poulton, Colonel C. Swinhoe, Mr. A. J. Chitty, Mr. G. C. Champion, and Mr. H. Rowland-Brown, having been received, and read at the three preceding meetings, Professor R. Meldola, seconded by Mr. A. J. Chitty, proposed that the Bye Laws be altered and amended accordingly.

The proposed amendments to Chap. iii. (*Management*), Chap. iv. (*Officers*), Chap. vii. § 1 (*Vice-Presidents*), Chap. xiv. §§ 3, 4

(*Withdrawal and Removal of Fellows*), Chap. xv. § 2 (*Privileges of Fellows*), and Chap. xix. §§ 1, 2 (*Annual Meeting*), were then agreed to and adopted by resolutions as follows:—

CHAP. III. *Management.*

The affairs of the Society shall be conducted by a Council consisting of the Officers of the Society hereinafter mentioned —other than the three Vice-Presidents—and of twelve ordinary Members to be chosen annually from among the Fellows. No Fellow shall be eligible as an ordinary Member of the Council for more than three years successively. Five shall be a quorum.

CHAP. IV. *Officers.*

The Officers of the Society shall consist of a President, three Vice-Presidents, a Treasurer, two Secretaries, and a Librarian. The Officers shall be chosen annually. No Fellow shall be eligible as President or be nominated as Vice-President for more than two years successively.

CHAP. VII. *Vice-Presidents. Section* 1.

1. The Vice-Presidents shall be nominated by the President from amongst the Members of the Council. Such nomination shall be declared at the Ordinary Meeting next after the Election of the President in every year.

CHAP. XIV. *Withdrawal and Removal of Fellows. Sections* 3 *and* 4.

3. In the month of November in each year the Council shall cause to be suspended in the library of the Society a list of the Fellows who owe more than two annual Contributions. If the Contribution due from any Fellow named in the said list shall not have been paid within three months after the first suspension of the list the Council may remove such Fellow from the Society, but notwithstanding such removal any Fellow removed shall continue liable to pay, and may be sued for the recovery of any money due from him to the Society. The Council may remit wholly or in part the entrance fee payable by any former Fellow rejoining the Society.

CHAP. XV. *Privileges of Fellows. Section* 2.

2. A Fellow shall not be eligible to any Office in the Society or to the Council unless he shall have paid his annual Contribution for the year previous to that in which the Election takes place.

CHAP. XIX. *Annual Meeting.*

1. The Annual Meeting of the Society shall be held on the third Wednesday in January.

2. The objects of the Meeting shall be to receive from the Council and hear read their Annual Report on the general concerns of the Society, and to elect the Council and Officers for the ensuing year.

Amendments to the proposed amendment of Chap. xix. § 3 moved respectively by Mr. W. J. KAYE, seconded by Mr. J. W. TUTT; by Mr. C. J. GAHAN, seconded by Mr. G. H. VERRALL; and by Mr. A. BACOT, seconded by Mr. L. B. PROUT, were negatived, and the original amendment agreed to and adopted by resolution as follows :—

3. The Council for the time being shall annually cause to be prepared a list which shall contain the names of such Fellows, being eligible, as they shall recommend to fill the Offices of President, Treasurer, Secretaries and Librarian for the year ensuing; and also the names of such Fellows as they shall recommend to be re-elected and of other Fellows to be elected into the Council. The list shall include the names of not less than twelve Fellows recommended as ordinary members of the Council.

The amendment to § 4 was proposed as follows :—

4. Copies of such list shall before the 20th of December be transmitted to every Fellow whose last-known residence shall be in the United Kingdom, and who shall have paid his subscription for the current year.

Mr. J. W. TUTT, seconded by Mr. H. ROWLAND-BROWN, moved to strike out the words, "Copies of such list," at the commencement of Chap. xix. § 4 as amended, and substitute the following words :—

"The list prepared by the Council shall be read at the Ordinary Meeting next but one before the Annual Meeting.

At the Ordinary Meeting preceding the Annual Meeting, the names of other candidates to fill any of the offices, or to serve as Members of the Council (each proposed and supported by at least four properly qualified Fellows of the Society) shall be received. Nominations by post made by four properly qualified Fellows, and received prior to this meeting, shall also be accepted. These shall be added to the Council's list, and copies of the complete list . . . ."

This amendment was carried on a show of hands, and the amendment, as amended, was carried.

The proposed amendment to Chap. xix. § 5 was then agreed to and adopted by resolution as follows :—

5. The Election shall be by ballot at the Annual Meeting, and copies of the final list shall be used as ballot papers. The President shall appoint two or more Scrutineers from the Fellows present not being Members of the Council to superintend the ballots and report the results to the Meeting. The Secretaries, assisted by the Treasurer, shall prepare a list of the Fellows entitled to vote, and each Fellow voting shall give his name to the Scrutineers to be marked on the said list, and shall then put his ballot paper into the respective receptacles to be provided for such occasion.

The amendment to § 6 was proposed as follows :—

6. A Fellow voting may strike out any name or names printed on the said list and insert in writing the name of any Fellow or Fellows in the place of the name or names struck out, and the Scrutineers shall record the votes accordingly, but any ballot paper which shall contain a less or greater number of names for any Office or position than the number to be elected to such Office or position shall be wholly void and be rejected by the Scrutineers. No ballot shall be taken unless nine or more Fellows shall be present.

On the motion of Mr. A. J. Chitty, seconded by Mr. J. W. Tutt, it was resolved to omit from the proposed amendment to Chap. xix. § 6, line 2, the words, "and insert in writing the name of any Fellow or Fellows in the place of the name or names struck out," and the words, "less or," line 5, and the amendment to Chap. xix. § 6 as amended was then agreed to and adopted by resolution.

The proposed amendments to Chap. xix. §§ 7, 8 were then adopted by resolution as follows:—

7. If from any cause any Election which ought to take place at the Annual Meeting shall not take place, then such Election shall be adjourned until the next convenient day, of which notice shall be given in like manner as is directed for the Annual Meeting.

8. The forms given in the Schedule shall be used, with such variations as may be considered by the Council necessary or desirable.

The form of Schedule and Instructions on the following page (*l*) was then adopted by resolution on the proposal of Mr. A. J. Chitty, seconded by Mr. H. Rowland-Brown, such Schedule embodying an amendment, proposed by Mr. W. F. Blandford, seconded by Mr. J. W. Tutt, and carried.

On the motion of the President, seconded by Mr. H. Rowland-Brown, it was further resolved that so much of the unamended Bye Laws as govern the election of the Council and Fellows should remain in force over the ensuing election for 1903.

The Ordinary Meeting was then resumed, and Mr. H. Goss, one of the Secretaries, brought up the names of those Fellows recommended by the Council for election into the Council for 1903.

On the motion of the President, seconded by Mr. H. Goss, the following Fellows were appointed Auditors for the current year: on the Council, Mr. R. Adkin, Mr. G. C. Champion, and Mr. H. Rowland-Brown; not on the Council, Colonel Yerbury, Mr. A. H. Jones, and Mr. R. W. Lloyd.

## THE SCHEDULE REFERRED TO IN CHAPTER XIX.

*Balloting List for the Election of Officers and Council.*

| Office. | List. |
|---|---|
| President. | Z. A. |
| Treasurer. | W. D. |
| Secretaries. | T. G. |
| | S. H. |
| Librarian. | N. M. |
| Council. | A. B. |
| | C. D. |
| | E. F. |
| | G. H. |
| | I. J. |
| | K. L. |
| | M. N. |
| | O. P. |
| | Q. R. |
| | S. T. |
| | U. V. |
| | W. X. |

*Instructions.*

In using the above list as a ballot paper a Fellow voting may strike out any name or names printed therein, but any ballot paper which when placed in the receptacle shall contain a greater number of names for any Office or Position than the number to be elected to such Office or Position shall be wholly void and rejected by the Scrutineers.

## ANNUAL MEETING.

January 21st, 1903.

The Rev. Canon Fowler, M.A., D.Sc., F.L.S., President, in the Chair.

Mr. Albert Hugh Jones, one of the Auditors, read the Treasurer's Balance Sheet, showing a balance of £26 10*s.* 7*d.* in the Society's favour.

Mr. Herbert Goss, one of the Secretaries, read the following

### Report of the Council.

During the Session 1902–1903 three Fellows have died, viz. Professor Dr. Carlos Berg, Director del Museo Nacional, Buenos Ayres, Mr. John William May, of Earl's Court, and Mr. Charles Marcus Wakefield, F.L.S., of Uxbridge.

Eight Fellows have resigned, eleven Fellows have been removed from the list for non-payment of their subscriptions, and twenty-three new Fellows have been elected. The number of Fellows who have died is far below the average, but the number who have resigned, or have been removed for non-payment of subscriptions is above the average; whilst the number of new Fellows elected is six less than last year. The Council hope that continued efforts will be made to increase the number of Fellows and to maintain the splendid progress made by the Society in recent years.

At present the Society consists of twelve Honorary Fellows and four hundred and sixty Life and Subscribing Fellows, making a total of four hundred and seventy-two, which, notwithstanding the losses by death, resignation and removal, is an increase by one on last year's list, and represents a membership greater than in any previous year of the Society's existence since its foundation, seventy years ago!

The Transactions for the year 1902 form a volume of 729 pages, containing twenty-three Memoirs, contributed by the following authors: Mr. Malcolm Burr, Mr. George C. Champion, Dr. Thomas Algernon Chapman, M.D. (three papers),

Mr. William L. Distant, Dr. Frederick Augustus Dixey, M.D., Mr. Horace St. John K. Donisthorpe, Miss Alice Embleton, B.Sc., Professor Auguste Forel, M.D., Mr. Sidney L. Hinde, Mr. W. F. Kirby (two papers), Mr. George W. Kirkaldy, Mr. Arthur M. Lea, Mr. Guy A. K. Marshall, Mr. Edward Meyrick (two papers), Professor Louis C. Miall, F.R.S., and Professor Gustave Gilson, Mr. Robert C. L. Perkins (three papers), Mr. Thomas H. Taylor, and Colonel Charles Swinhoe.

Of these twenty-three papers two relate to *Coleoptera*, two to *Hemiptera*, four to *Hymenoptera*, seven to *Lepidoptera*, and four to *Orthoptera*. In addition there are four papers which are not confined to the descriptions of, or references to, any one order of insects, viz. Firstly, Mr. Champion's paper which, besides giving an account of an excursion to Central Spain, which he made in company with Dr. Chapman in July 1901, contains lists of, and notes on, the *Coleoptera* and *Hemiptera-Heteroptera* collected by them. Secondly, Mr. Guy A. K. Marshall's paper on "Five Years' Observations and Experiments on the Bionomics of South African Insects, chiefly directed to the Investigation of Mimicry and Warning Colours, with a discussion of the results suggested by them, by Professor Poulton, F.R.S., and an Appendix containing descriptions of new species of Diptera, Hemiptera, Hymenoptera, and Coleoptera by Mr. E. E. Austen, Mr. W. L. Distant, Colonel C. Bingham, Mr. G. A. K. Marshall, and Mons. Jules Bourgeois." Thirdly, Mr. Hinde's paper on "The Protective Resemblance to Flowers borne by an African Homopterous Insect," communicated by Professor Poulton; and Fourthly, Mr. Taylor's interesting anatomical paper communicated by Professor Miall, F.R.S., "On the Tracheal System of Simulium."

Although the papers on *Lepidoptera* and *Coleoptera* are not so numerous as usual, it is satisfactory to have published so many papers dealing with *Orthoptera*, *Hymenoptera*, *Hemiptera*, *Diptera*, and general subjects of interest to Biologists.

The Memoirs above referred to are illustrated by twenty-eight plates, of which five are coloured. In no previous year of the Society's existence has so large a volume of Transactions been issued with such a number of plates. Half

the cost of Plates VII. and VIII. has been defrayed by Profession Miall, F.R.S., half the cost of Plates IX., X., XI., XII., XIII., XIV., XV., XVI., XVII., XVIII., XIX., XX., XXI., XXII. and XXIII. has been contributed by Professor Poulton, F.R.S., who has also paid the entire cost of Plates XXVI. and XXVII., while Mr. G.W. Palmer, M.P., contributed £30 towards the expense of printing Mr. Marshall's Paper.

The interest shown by the Fellows during the past year by their exhibitions and discussions, has enabled the Secretaries to largely increase the reports of the Proceedings, which compare very favourably with those for 1901, or indeed for any previous year of the Society's existence, as they already extend to about fifty pages.

The Council formerly consisted of thirteen Fellows; in 1897 this number was raised to fifteen, and under the amended Bye Laws the number has been raised to seventeen, thus affording, as the Society adds to its numbers, a proportionate increase in the representation of the Fellows on the Council.

It is hoped that this addition to the numbers of the Council will not diminish its executive capacity and powers of administration, but rather that such increase may justify Solomon's words, " Where no counsel is the people fall ; but in the multitude of counsellors there is safety."

During the past year nineteen Volumes—in addition to Periodicals, Pamphlets and Reprints—have been added to the Society's Library. That the Library is valued and used by the Fellows is proved by the fact—according to the Resident Librarian's Report—that two hundred and fifty-four volumes have been borrowed during the year.

The Treasurer reports that after carrying forward to 1903 the sum of £9 9*s.* 0*d.* received for subscriptions in advance there remained at the end of 1902 a cash balance of £26 10*s.* 7*d.* in favour of the Society. Private generosity has enabled us to publish an annual volume of Transactions which in bulk is very far in excess of that for any former year, and to still have a moderate balance—compared with last year—in hand from current receipts. The general financial position of the Society remains perfectly sound and continues to improve.

Latterly each year has surpassed its predecessors in the amount obtained for current subscriptions; this was strongly accentuated in 1902. The amount received for subscriptions in arrear much exceeded expectations. To these two facts (in addition to the donations) is mainly due the balance in hand just alluded so. No Life Composition has been received in 1902, and the investments remain as before. The item of Expenditure under the heading "Rent and Office Expenses," always large, is in 1902 exceedingly so, amounting to nearly £200. It may be well, therefore, to explain that the cost of distributing the Transactions forms part of this item, and accounted for about £55, partly consequent on the increased size of the volume; Rent and Salary absorb £105; the comparatively small sum remaining includes the expenses for tea after the meetings.

In conclusion the Council have to congratulate the Fellows on the increasing prosperity of the Society.

Entomological Society,
11, Chandos Street, Cavendish Square, W.
21*st January*, 1903.

The Secretaries not having received any notice proposing to substitute other names for those contained in the list prepared by the Council, the following Fellows constitute the Council for 1903—1904: Colonel Charles T. Bingham, F.Z.S.; Malcolm Burr, B.A., F.L.S., F.Z.S.; George C. Champion, F.Z.S.; Dr. Thomas A. Chapman, M.D., F.Z.S.; Arthur John Chitty, M.A.; Hamilton H. C. J. Druce, F.Z.S.; The Rev. Canon Fowler, M.A., D.Sc., F.L.S.; Herbert Goss, F.L.S., F.G.S.; Robert McLachlan, F.R.S., F.L.S.; Professor Raphael Meldola, F.R.S., F.C.S.; Professor Louis Compton Miall, F.R.S.; The Rev. Francis D. Morice, M.A.; Professor Edward B. Poulton, M.A., D.Sc., F.R.S., F.L.S.; Henry Rowland-Brown, M.A.; Dr. David Sharp, M.A., F.R.S., F.L.S.; Colonel Charles Swinhoe, M.A., F.L.S., F.Z.S.; Colonel John W. Yerbury, R.A., F.Z.S.

The following are the Officers elected: *President*, Professor Edward B. Poulton; *Treasurer*, Robert McLachlan; *Secre-*

*taries*, Herbert Goss, Henry Rowland-Brown ; *Librarian*, George C. Champion.

The Balance Sheet and Report having been unanimously adopted, Canon Fowler, the President, delivered his Address. A vote of thanks to the President for his Address, and for his services as President during the past year, was moved by Professor Poulton, F.R.S., seconded by Professor Meldola, F.R.S., and carried. The President replied. A vote of thanks to the Officers was moved by Professor Meldola, and seconded by Mr. Charles O. Waterhouse and carried. Mr. McLachlan, Mr. Goss, and Mr. Rowland-Brown replied.

## ENTOMOLOGICAL SOCIETY OF LONDON.

### Balance Sheet for the Year 1902.

| Receipts. | £ | s. | d. | Payments. | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Balance in hand, 1st Jan., 1902 ... ... ... ... | 56 | 16 | 1 | Printing Transactions, etc. | 293 | 9 | 1 |
| Subscriptions for 1902 ... | 368 | 11 | 0 | Plates, etc. ... ... ... | 131 | 19 | 0 |
| Arrears ... ... ... ... | 31 | 10 | 0 | Rent and Office Expenses ... ... ... ... | 197 | 14 | 3 |
| Admission Fees ... ... | 44 | 2 | 0 | Books and Binding ... ... | 32 | 13 | 4 |
| Donations ... ... ... ... | 78 | 12 | 0 | Subscriptions in advance, per contra, carried to 1903 ... ... ... ... | 9 | 9 | 0 |
| Sales of Transactions, etc. | 77 | 6 | 9 | Balance ... ... ... ... | 26 | 10 | 7 |
| Interest on Investments:— | | | | | | | |
| Consols ... ... £18 13 4 | | | | | | | |
| Westwood Bequest 6 15 1 | | | | | | | |
| | 25 | 8 | 5 | | | | |
| Subscriptions in advance | 9 | 9 | 0 | | | | |
| | £691 | 15 | 3 | | £691 | 15 | 3 |

### ASSETS.

| | | | |
|---|---|---|---|
| Subscriptions in arrear considered good (say) ... ... | £21 | 0 | 0 |
| Investments:— | | | |
| Cost of £734 12*s.* 11*d.* Consols ... ... ... ... ... | £729 | 3 | 0 |
| Cost of £239 12*s.* 4*d.* Birmingham 3 per cent. ... ... | 250 | 0 | 0 |
| Balance in hand ... ... ... ... ... ... ... ... ... | 26 | 10 | 7 |

NO ASCERTAINED LIABILITIES.

Robert McLachlan,
*Treasurer.*

Audited and found correct.

A. Hugh Jones.
H. Rowland-Brown.
R. Wylie Lloyd.

14th January, 1903.

# THE PRESIDENT'S ADDRESS.

GENTLEMEN,

At the beginning of my last address I was able to say, without fear of contradiction, that the report of the Council was the most satisfactory that had ever been presented to the Society: I can now, however, say that the report for this year is even better: in spite of losses our numbers are somewhat greater than they were this time last year, and never before in our seventy years' existence as a Society has such a volume of Transactions been published, containing as it does some 800 pages and no less than twenty-eight plates. Notwithstanding our large expenditure we have still a fair balance in hand: our thanks for these results are due to our energetic Treasurer, Secretaries, and Librarian: all these officers give up a very large proportion of their spare time to further the interests of the Society, and I should like to see the question of a paid Assistant-Secretary seriously brought forward. After much deliberation on the part of the Council, certain changes in the Bye-laws have recently been submitted to the Society, and adopted with a few alterations; it is hoped that the amended Bye-laws will meet with the general approval of the Fellows. I should also like to call attention to certain improvements in the index which have been introduced by the Secretaries.

If we glance at the Transactions and Proceedings of the Society, it is evident that much more good work is being done at other orders beside the Lepidoptera, than used to be the case some few years ago—but we still want many more students of the Diptera. A special feature of our Transactions for the past year is the multiplication of papers on Life History and Bionomics: this is a great improvement upon the times when I as Secretary used to draw up the

index, and found it to consist as a rule of long lists of newly-described Lepidoptera, with, occasionally, a certain amount of Hymenoptera and Coleoptera thrown in. The present general interest in most of the less worked orders augurs well for the future of Entomology in this country.

Our obituary is again a small one.

Professor Carlos Berg joined the Society in 1886: he was Director of the National Museum at Buenos Ayres: at first he held a subordinate position, but in 1892 he succeeded Burmeister as Director. His studies embraced nearly the whole of the Insecta, and he has given us much that is interesting concerning the entomology of Patagonia, Chili, Tierra del Fuego, etc.: he was a native of the Russian Baltic Provinces, and was formerly Librarian at Riga.

Mr. John Edward Fletcher joined the Society in 1865 and resigned his membership in 1901: he was a strong example of the amount of valuable knowledge of nature that can be amassed by a self-taught working man: he was born near Worcester, and lived in or near that city for the whole of his life, following the occupation of a working glover: his additions to the British lists were very numerous, and there is scarcely an order in which he did not make discoveries: one of his chief characteristics was the accuracy of his determinations: his local collections are very full, and we are glad to hear that they are likely to be acquired by his native city, to which they will be of the greatest value.

Mr. Charles Marcus Wakefield was the only son of Mr. D. Bell Wakefield, Judge of the Supreme Court in New Zealand: he was educated in England, and afterwards held an official appointment in New Zealand, but retired owing to bad health, and came back to England, where he bought an estate at Uxbridge, at which place he lived until his death: in New Zealand he collected a large number of insects, which were worked out by specialists, to whom he liberally presented them: he was elected a Fellow of the Society in 1876.

Mr. John William May was one of the oldest members of the Society, having been elected in 1860: he chiefly studied *Coleoptera* and *Hymenoptera*, and in the latter order he had

a considerable collection of British parasitic forms of his own taking: for some years he was Consul-General for the Netherlands (in which post he succeeded his father), and he was a Knight of the Netherlands Lion. Though practically unknown to the present generation of entomologists he used to be a constant attendant at the meetings of the Society, and he was a member of the Council in 1883 and 1884.

Among foreign entomologists not members of the Society the following deserve mention:—

Dr. Joseph Kriechbaumer was appointed Assistant in the Zoological State Museum in Munich as far back as 1859, and in 1898 he became Second Curator: he wrote to a certain extent on *Coleoptera* and *Diptera*, but it was on *Hymenoptera* that he was looked up to as an authority, and he was especially attached to the *Ichneumonidæ*.

Mr. Homer Franklin Bassett was born at Florida (Mass.) in 1826: after filling various positions he was appointed Librarian to the Bronson Library in Waterbury (Conn.), a post which he held until 1901. He did much good work at the *Cynipidæ* and other gall-flies.

Dr. Pierre Jules Tosquinet was President of the Entomological Society of Belgium: it was apparently late in life when he seriously took up entomology: he devoted himself to the parasitic *Hymenoptera*, especially *Ichneumonidæ*, and acquired a wide knowledge of the group, but he did not publish much: he was a man of considerable importance in Belgium, having been Military Inspector-General for Health, and being at the time of his death President of the Central State Commission for Vaccination: he was an officer of the order of Leopold, and held the Civil Cross of the first class and the Military Cross.

Professor Adolfo Targioni-Tozzetti was director of the department of invertebrate Zoology in the Museum at Florence: as an entomologist he published several papers on *Orthoptera* and much useful information on *Aphides*, *Coccidæ*, etc.: he also took an active part in the Italian Phylloxera commission. He was one of the founders of the Societa Entomologica Italiana, and many of his pages were published in its Bulletino: the Society still exists, and, although it has

never been prominent, it has nevertheless done good work in keeping alive an interest in entomology (especially of a local nature) in Italy.

In my last address I endeavoured to discuss the question of Cryptic Coloration and Mimicry particularly as affecting the Coleoptera: very little had previously been written with regard to this branch of the subject, the researches having been chiefly confined to the Lepidoptera; as regards this order the chief argument which had been put forward against the theories of Wallace, Bates, Poulton and others, was that the evidence of systematic attacks by birds and other animals upon Lepidoptera was scanty and untrustworthy. I therefore thought it best to treat at some length of the proofs that Coleoptera formed a large part of the food of many birds, and especially of certain birds of prey which might hardly have been expected to devour them, and further that certain species were readily eaten, others less readily, while some appeared to be entirely rejected: the natural inference to be drawn from this was that if the Coleoptera were devoured the Lepidoptera were also systematically eaten, but that their remains were, from the nature of the case, not detected like those of the chitinous-winged Coleoptera: since my address was published Mr. Guy Marshall and Professor Poulton have published their classical paper in our Transactions, which almost renders it unnecessary to produce any further evidence. I may, however, be allowed to mention a few further facts with regard to Coleoptera eaten by birds which have come under my notice during the past year. Mr. William Evans, of Edinburgh, who has devoted a great deal of time and trouble to this subject, has kindly sent me observations on the following birds:—Kestrel, Bittern, Water Rail, Dotterel, Curlew, Sanderling, Green Sandpiper, Turnstone, Dunlin, Redwing, and Starling: the casting of a Kestrel from near Kirknewton, Midlothian, contained remnants of the following beetles:—*Carabus catenulatus*, *Pterostichus niger* and *P. strenuus*, *Anchomenus albipes*, *Silpha atrata* and *Cryptohypnus riparius*: in the stomachs of the other birds examined were found specimens of *Carabidæ*, *Dytiscidæ*, *Hydrophilidæ*, *Staphylinidæ*,

*Heteroceridæ*, *Byrrhidæ*, *Elateridæ* and *Curculionidæ*, but not a single specimen of either *Coccinellidæ* or *Telephoridæ*. In the table of the food of a number of rapacious birds which I gave last year I mentioned that out of seventy Long-eared Owls (*Asio otus*, L.) the pellet of one shewed remains of a small bird and of the remainder the remains of mice and shrews, and I further added that this species is also recorded as feeding on large moths and beetles. Mr. Newstead I find has recorded the fact that he found a number of pellets ejected by this owl, quite twenty-five per cent. of which consisted of the remains of large dung-beetles belonging to the genus *Geotrupes*, some pellets being entirely made up of these and grass: rooks too are partial to these large Scarabæidæ; the rook is an omnivorous feeder, and is a very useful bird as long as it is able to procure wire-worms, caterpillars, such as those of *Agrotis segetum*, etc., for its young, but it is also very partial to fruit, and will also eat eggs or even destroy young birds at times: rooks and carrion crows have been known to carry off a crop of pears, and I know from experience that they will entirely strip a cherry-tree before the fruit is nearly ripe. The shrikes or butcher-birds are fond of the large burying beetles, *Necrophorus humator* and *N. mortuorum*, and blackbirds and thrushes do good service in destroying species of *Otiorrhynchus* and *Sitones*, which are often serious pests to gardeners and farmers.

In the paper on "The Bionomics of South African Insects" which I have already alluded to, Mr. Marshall records a number of experiments which he made with a kestrel (*Cerchneis naumanni*), which ate specimens of inconspicuously coloured *Curculionidæ*, and also certain *Carabidæ* belonging to the genus *Graphipterus* if offered head first: if offered tail first they were rejected from fear of the acid discharge so characteristic of this family: species of *Lycus*, *Clerus*, *Epilachna*, and *Mylabris* were also rejected, but, somewhat curiously, a *Clythra* with strong Coccinellid odour was eaten by the bird after some hesitation: a considerable list is given of species refused, but, according to Mr. Marshall's observations, they were refused "usually after tasting": it must indeed be taken into consideration, that the kestrel was a

young bird, and therefore, as Professor Poulton remarks, it is probable that it had never before had experience of many of the species, but the facts seem at first sight to somewhat discount the value of the synaposematic colouring which was characteristic of all or nearly all the rejected insects. At the same time, it must be allowed that in a long list of birds whose stomachs were examined by Mr. Marshall, there is almost a complete absence of all the aposematic groups, except in the case of two or three species which were also found to eat Reduviid or Pentatomid bugs, or distasteful moths, thus showing that their food was distinctly abnormal: this proves conclusively that, in the case of old birds at all events, the synaposematic colouring is of the greatest importance, unless we adopt the untenable hypothesis that the tasting process is continued through life, and that no remains are found because the distasteful insects are invariably rejected.

In my former address I mentioned ten methods in which the Coleoptera are protected: on further consideration, however, I quite agree with Professor Poulton in thinking that some of these are included under or connoted by others, and that therefore the number should be reduced to five, as follows:—

1. The assimilation of colour or form to environment, including resemblance to droppings of birds and such-like substances: we have no right to speak of these as more than cryptic, for we can form no idea as to their being unpleasant or otherwise to insectivorous animals or birds.

2. The possession of a very hard integument: it must be noted in this connection that the beetles with a very hard integument are usually cryptic, especially the genera of South African Curculionidæ (*Brachycerus*, etc.), which I have before referred to: moreover the Curculionidæ have peculiarly strong and wiry legs, and the large species could probably cause considerable inconvenience and pain by means of the legs and snout if they fastened on anything that attacked them: any collector of Coleoptera must have noticed this in a small way in the case of our common Otiorrhynchidæ. In connection with this subject I was very much interested in the account

given by Mr. Marshall of the behaviour of a kestrel (*Cerchneis rupicoloides*) when given a large Buprestid beetle (*Psiloptera valens*): the bird took it with apparent pleasure and endeavoured to hold it with its foot and eat it, but after a peck or two it slipped from its grasp: the experiment was repeated several times with the same result: the torpedo-like shape and hard and slippery integument appear to prevent the destruction of the insect by any bird which cannot swallow it entire: baboons, however, readily ate all species of *Psiloptera*.

3. Aposematic or warning coloration, including warning attitudes and warning sounds: moreover, as it is plain from what has been already said, that all species with warning colours are largely tasted by young birds, at all events before being avoided, there must always be some unpleasant odours or juices present in all aposematically-coloured insects which are not mimicking species: without these warning colours would have no significance, for all insects possessing them, instead of having been supported and increased by natural selection, would have been promptly and rapidly eliminated.

I have before said that we know nothing of the tastes of the lower animals; scents such as those of *Aromia* and *Callichroma* which are agreeable to us, may be nauseous or even harmful to insect-eaters; as bearing upon this it is worthy of mention that Mr. Shelford has noticed that certain of the Callichrominæ are the only representatives of the Longicorns of Borneo, with the exception of the *Clytinæ*, which are mimicked by other distantly-related Longicorns. Mimicry of this sort appears invariably to prove distastefulness on the part of the mimicked species.

Again, warning attitudes have usually some effective means of defence to back them up; thus the larva of the Puss Moth can eject strong formic acid, and *Ocypus olens* can inflict a severe bite if its terrifying attitude is disregarded: occasionally, however, an insect appears to depend entirely upon its appearance, as in the case of larvæ which resemble snakes, and in such cases there is really no need for ulterior means of defence; Mr. Marshall has procured most striking evidence as to the alarm shown by baboons on being offered the larva

of *Chœrocampa osiris* (which in general colouring is like the common puff-adder), and it is plain that such resemblances, coupled as they are usually with warning attitudes (as in *Chœrocampa elpenor*), are of the greatest service in protecting many insects from attack and consequent destruction.

The warning attitudes of certain Coleoptera are well known: they are perhaps most common among the Carabidæ: the genus *Anthia* has a peculiar warning attitude, but I am doubtful whether the white spots on certain of the species are aposematic, as Professor Poulton thinks, nor do I think with him that the spots at the apex of the elytra in various Carabidæ are directive; in speaking of the anal secretion which is common to so many of the Carabidæ, Mr. Marshall says (*l. c.* p. 511) that in the smaller species "the utility of the secretion lies in the fact that it enables the insects momentarily to disconcert their enemies, and this, owing to their great activity, gives them an opportunity to escape. Under the circumstances it is evidently of importance that an attack from an enemy should be directed to the anal portion of the body in order to ensure its receiving the discharge." The beetles, however, are not distasteful as a whole, and, in such a case, it does not appear to be of much advantage to warn an enemy towards the tail only; a few specimens might escape, but the majority would be eaten after a few experiments: perhaps these patches are recognition markings, but it is possible that they are of no significance, for they are very far from being universal: they are absent or not present in any marked degree, for instance, among the Brachinidæ, in which family we might expect them, on Professor Poulton's theory, to be especially conspicuous. Large eye-spots are found in certain Elateridæ, but I have considered these as presenting a cryptic appearance, and I believe that the light spots at the sides and apex of the elytra of various beetles, which touch the margin, are really cryptic rather than aposematic, for they break up the outline of the insect, and the combination of the black or brown and white renders the insect more or less inconspicuous, on the same principle that a zebra, or a duck on the surface of the water,

is cryptically protected by its coloration. This is, I think, certainly the case with many Cicindelidæ, whose apical spots Professor Poulton regards as due to their mimicry of Carabidæ.

With regard to warning sounds the whole question of the stridulating organs of insects is a most interesting one, whether we consider the physiological structure of these organs (a study which appeals strongly to many entomologists), or whether we consider their object and purpose: of course the sounds are often sexual, but in certain cases they appear to be true warning sounds. The evidence of Mr. Marshall on this point is very valuable, for he was enabled to prove that both a kestrel and a baboon showed evident alarm at the stridulation of a Longicorn (*Ceroplesis fallax*): in many instances the stridulation is backed up by an unpleasant and probably noxious odour.

4. The imitation of a distasteful insect by a tasteful one whether belonging to the same or a different order: Bates, in his original paper, says that "mimetic analogies are not confined to the Lepidoptera: most orders of insects supply them: but they are displayed only by certain families," and he goes on to speak of *Diptera* and *Hymenoptera* and certain Clearwing moths (*Trochilium*) as mimicking bees, wasps, etc.; furthermore he uses the resemblance of a moth to a wasp as the analogy by which to understand the resemblance of a *Leptalis* to a Heliconine, and he even speaks of mimicry as "the deceptive resemblance of species to some other definite object, including ordinary cryptic resemblances." Batesian mimicry, therefore, as Professor Poulton has pointed out to me, has not been extended, but restricted for the sake of convenience.

5. In treating of the question of Synaposematic or Common Warning Coloration in my last address I expressed a hope that I might be able to deal with it at greater length on a future occasion: but this is practically rendered unnecessary, at any rate for the present, as the subject has been so fully discussed and so well illustrated in Mr. Marshall's paper. Nothing that can be said in proof of the theory can be more convincing than the plates (Trans. Ent. Soc., 1902, Part III, pl. xviii and xix)

illustrating the Lycoid and Cantharoid groups respectively: the observations which remain to be made with regard to the general subject are inexhaustible, but it appears plain that the chief families of Coleoptera which enter into synaposematic combinations are the following, and I should be inclined to group them in the following order of importance:—1. Malacodermidæ, Melyridæ and Cantharidæ. 2. Coccinellidæ. 3. Erotylidæ, Endomychidæ and Chrysomelidæ. 4. Cleridæ. Certain other families, such as the Pyrochroidæ and Lagriidæ, might perhaps be added.

It is probable also that among the Longicorns, members which imitate species of all the families above mentioned, as well as many others, there are a considerable number of distasteful species, and that in this respect they resemble the Papilionidæ among the Lepidoptera.

Perhaps one of the most striking of the many instances of synaposematic coloration is found in the assumption of a simple yet peculiar banding or marking by insects of different orders (or widely differing insects of the same order) in a particular country or district. Thus we have yellow Australian species of Diptera, Hymenoptera and Coleoptera with a very marked broad black band round the abdomen, and so very closely resembling each other, while in Africa we get sets of dark-winged insects of all orders, or groups of Hymenoptera, with the apex of the abdomen broadly yellow, which are mostly synaposematic.

In all the groups it cannot be too strongly insisted upon that the general appearance of the insects when on the wing, or in motion of any sort, must always be taken into consideration. Many insects which are totally different when at rest are very hard to distinguish when flying, and it is during movement that protection is most needed: there can be no better proof that the resemblance between *Clytus arietis* and a wasp is a real and significant one than the fact that the beetle bears out its wasp-like resemblance in its movements. To those who do not take conditions of flight into consideration, Mr. Marshall's plates (Trans. Ent. Soc., Part III, pl. xxi to xxiii), representing the dark-winged Mashonaland Aculeates and their mimics, and other South

African Aculeates and their mimics, convey many mistaken impressions.

It seemed to me that, at the risk of some repetition, it might be of some advantage to bring before the Society these somewhat amended views on the question of Cryptic Coloration and Mimicry in the Coleoptera : I do not go as far in the whole matter as many do; there are certain naturalists whose theories, ingenious though they may be, are so fantastic that they tend to bring discredit on the whole question in the eyes of those who are inclined to reserve their judgment and to view the general subject with suspicion: one of the chief of these is M. Portschinski, whose papers on "Coloration marquante et Taches ocellées" even Professor Poulton characterises as "remarkable and highly imaginative." It was M. Portschinski who called attention to the fancied resemblance of the chrysalis of *Limenitis populi* to a chrysalis which has been pecked by a bird, and is therefore passed over; this appeared to be rather far-fetched, but is as nothing to his belief that "in the sounds made by certain irritated Mantides, as they display the spots on their raptorial legs, he hears a representation of the rushing sound of a warning liquid forced through a fine aperture:" at the same time, it will be interesting to be able to refer to the detailed account of the works of this well-known Russian entomologist which Professor Poulton promises to give on a future occasion.

The theory of Cryptic Coloration and Mimicry as a whole seems to be so well substantiated by an ever-increasing host of indisputable facts that it is hardly necessary to consider at length objections to it as a whole, although over-refinement in individual cases is most strongly to be deprecated. At the same time, I should like to speak briefly on one or two points put forward by Mr. Bateson, a well-known opponent of the theory of Colour-adaptation to Environment, in his well-known book, *Materials for the Study of Variation.** After pointing out that, as Darwin and others have often shown, the characters which vividly differentiate species are not, as a rule, capital facts in the constitution of vital organs, but rather details which seem useless and trivial, such as patterns

* Introduction, page xi.

of scales, sculpture, etc., he proceeds as follows:—"These differences are often complex and are strikingly constant, but their utility is in almost every case problematical. For example, many suggestions have been made as to the benefits which edible moths may derive from their protective coloration, and as to the reasons why unpalatable butterflies in general are brightly coloured; but as to the particular benefit which one dull moth enjoys as the result of its own particular pattern of dulness as compared with the closely similar pattern of the next species, no suggestion is made. Nevertheless these are exactly the real difficulties that beset the utilitarian view of the building-up of species. We knew all along that species are *approximately* adapted to their circumstances: but the difficulty is that wherever the differences in adaptation seem to us to be approximate, the differences between the structures of species are frequently precise. In the early days of the theory of Natural Selection it was hoped that with searching the direct utility of such small differences would be found, but time has been running on and the hope is unfulfilled." At first sight there seems to be something in these objections, but, in the first place, our knowledge of details is necessarily very small and cannot be worked out in fifty or perhaps five hundred years with regard to individual species. In the second place, we may with reason say that we *have* very much advanced in such knowledge; to refer to Mr. Bateson's own example, Lepidopterists will tell us that the pattern of one dull moth may be of the greatest advantage to it in comparison with the closely similar pattern of the next species, if its habits, the trees it rests on, etc., are all taken into consideration. In the third place, the very dissimilarity of individual examples of one cryptically-coloured species (*e.g.* the underside of *Kallima inachis*) is of itself a help to, as well as a proof of, adaptation to environment: in the case of cryptically-coloured moths or beetles too much uniformity would evidently be a positive disadvantage in the race for life.

Moreover, the general facts of Müllerian or synaposematic mimicry afford a clear proof that it is only an approximate adaptation as regards certain external details which is neces-

sary for the preservation of vast numbers of species belonging to different orders, the structural differences between which are of course precise. And here we may perhaps pass on to the consideration of quite a different subject, which is suggested to us by the mention of the precision of these structural differences; how did they arise? how were they established? and, above all, how were they differentiated to preciseness at such early geological periods? With regard to the first origin of the Insecta we know absolutely nothing: it has been the custom for some time to pre-suppose that they originated in some single form such as *Campodea*, which, according to Haeckel, should be looked for above the Silurian rocks, but this is pure hypothesis, and has not a single fact in the geological record to support it: "the Silurian cockroach," as Mr. Goss, who has done so much good work on the subject, says, "though differing in detail from any existing or extinct form, is, in its imago state, as far removed from the hypothetical ancestral form, as any existing representative of the class. Of course it does not follow that an ancestral form may not be discovered, and Packard considers that the larval cockroach bears a strong resemblance to Lepisma (a genus of *Thysanura*), and therefore the *Orthoptera* are descended from *Thysanura*, which latter order comprised the lost type, from which the Insecta, in the main, drew their origin." *

The earliest known insects belong to the *Orthoptera*, *Neuroptera*, and *Hemiptera*, and to an extinct Neuropteroid order, *Palæodictyoptera*: the types were strongly differentiated even in the earliest times, but the structure appears to have been more homogeneous in some respects. Sir John Lubbock (now Lord Avebury), writing in 1876 on some of the early insects, says that, although in some respects less specialised than existing forms, they "are as truly and as well characterised insects as any now existing; nor are we acquainted with any earlier forms which in any way tend to bridge over the gap between them and the lower groups." This is pre-eminently true of the Coleoptera, which from the time of their first appearance in geological strata have practically

* "On some recently discovered Insecta from Carboniferous and Silurian Rocks," by Herbert Goss, 1885.

undergone no change: it is true that the time at which the Order first appeared is somewhat doubtful, but it is almost certain that it did not exist during the Palæozoic period.* Mr. Goss is of opinion that it appeared towards the end of this period, and records two species of Coleoptera from the Carboniferous, viz. *Curculioides anstiei*, Buckland, from the Ironstone of Coalbrook-dale, Shropshire, and *Troxites germari*, Goldenburg, from the Coal Measures of Saarbrück: the latter fossil, however, is an obscure object, and as Brongniart has suggested that it may be the fruit of some plant, it is clear that it is, in all probability, not a beetle at all: and with regard to the former Dr. Buckland appears to have described two insects from Coalbrook-dale as belonging to *Curculioides*, under the name of *C. anstichii* and *C. prestwichii*: as, however, Dr. Woodward has decided that *C. prestwichii* should be referred to the Arachnida, it is evident that the genus is very doubtfully Coleopterous at all. Apart from these records, five remains of beetles are said to have been furnished by the Silesian culm (Carboniferous), one being the elytron of a Carabid or Tenebrionid, and borings have been found in Coal Measures which are similar to those made by Scolytidæ. This is all the evidence that I have been able to find for the existence of Coleoptera during the Palæozoic period; it will be seen that it is very fragmentary and unsatisfactory, and, in the present state of our knowledge, we are not justified in placing the first appearance of the order before the Mesozoic period: three species only (and one larva, according to Scudder) have been recorded from the Triassic rocks, but in the Jurassic period (Lias and Oolite) beetles are abundant, and are far more numerous than the insects belonging to any other order: most of the chief families now existing are represented and fully differentiated, and the genera and even the species in many cases are almost identical with those now living: with regard to the first origin of the Coleoptera we cannot, of course, speculate with any show of reason. Scudder believes that the ancestors of the order were wood-boring

* It must always be remembered that the hard and practically indestructible integument of the Coleoptera is of itself a strong proof that members of the order did not exist in any rocks or strata in which they are not found: we cannot say the same of the much more delicately formed Lepidoptera.

*Palæodictyoptera*, which gradually assumed hard elytra: but we have absolutely nothing in the geological record to support this, nor are there any species which can be considered transitional between this and other orders: all we know is that the Coleoptera not only appeared, but appeared in vast numbers and as highly differentiated as at the present time during the age of the great Saurian reptiles, before the great mass of our existing genera, and even families, of fish and reptiles had come into existence.* It is this persistence of type among the Insecta, coupled with the enormous differentiation of species and varieties, that is so striking: with regard to the persistence of type the explanation is to be found, perhaps, in the fact that the various orders became adapted at an early period to their special modes of life, and that therefore there has been, in the main, no need for any structural alteration, although external differences are still being brought about, partly by discontinuous variation, and partly by natural selection. I know that many people are entirely at variance with any theory of discontinuous variation, but I think that both in Coleoptera and Lepidoptera we come across sports which have, apparently, more or less suddenly broken off from the type and are, practically, new species. The variety of species, of course, in both Lepidoptera and Coleoptera is infinite. In a letter I received recently from Dr. A. R. Wallace, after speaking of the enormous differentiation of families, genera, and species, the majority of which are quite well defined, he proceeds as follows:—"Again, the enormous variety of species in many of the genera, varying every 100 miles or so in the monotonous Amazon plain, in every valley of the Andes, and in every island of the Malay Archipelago, shows how variable and adaptable they are under the slightest diversity of conditions. Taking all these facts into consideration, and always remembering the tremendous severity of the weeding-out process, so that of the hundreds of larvæ and imagos produced by one female butterfly, moth or beetle, only two on the average survive to breed and replace the two parents, and there seems to be no difficulty whatever in the

* "The Geographical Distribution of Animals," A. R. Wallace, vol. i, p. 176, 1876.

slow and continuous production of every kind of protective resemblance, including mimicry."

In the face of the facts before us this is an explanation that is far more likely to commend itself, than to say with Mr. Bateson,* that "it would be simpler to regard the constancy of the tints of the several species and the rarity of the intermediate varieties as a direct manifestation of the chemical stability or instability of the colouring matters, rather than as the consequences of environmental selection for some special fitness as to whose nature we can make no guess." To any one who has at all studied the subject such an explanation seems quite untenable; at the same time, it must be allowed that the intermediate varieties are not only rarely found, but are often absent altogether. It must be admitted that they may have been present and are now extinct, but there seems to be no *primâ facie* reason why discontinuous variation may not, at any rate, have been an appreciable factor in the production of species.

It is impossible to trace in any way the gradual development of the Coleoptera; and it is quite impossible to state which was the earliest family. Some writers have believed the Rhynchophora to be the most archaic form of the order: Dr. Leconte, for instance, is of opinion that "the Rhynchophora, being the lowest type of the Coleoptera, are therefore geologically the oldest":† judging, however, from the analogy of the *Blattidæ*, I should be inclined to look for the earliest of the Coleoptera among the less strongly developed genera of the *Heteromera*, or perhaps among the *Malacodermidæ*. We have no guide whatever as to the order in which the majority of the families appeared, for in the Rhætic series and the Lias we find the following fully differentiated:—*Carabidæ*, *Hydrophilidæ*, *Gyrinidæ*, *Scarabæidæ*, *Nitidulidæ*, *Peltidæ*, *Cryptophagidæ*, *Lathridiidæ*, *Mycetophagidæ*, *Byrrhidæ*, *Aphodiidæ*, *Buprestidæ*, *Elateridæ*, *Lampyridæ*, *Telephoridæ*, *Cistelidæ*, *Curculionidæ*, and *Chrysomelidæ*.

We have before briefly called attention to the fact that the two groups in which mimicking species are most often found

* *l. c.*, Introduction, p. 23.

† "Rhynchophora of America, North of Mexico," Introduction, p. vii.

are the *Longicornia* and the *Heteromera:* the *Longicornia* are a well-marked group, and as they appear to have been some of the latest of the Coleoptera, it is not perhaps surprising that they imitated more ancient groups; but the Heteromera, or some of them, appeared at a very early date, and such an explanation will not hold in their case. It is, however, very probable that the *Heteromera* do not form a unit at all. The chief character by which the members of the group are distinguished, and from which it takes its name, is the fact that the anterior and intermediate tarsi are 5-jointed and the posterior tarsi 4-jointed; there are, however, many instances of heteromerous beetles in other large series, as, for instance, *Anisotoma*, *Acritus*, the male of *Rhizophagus*, etc., so that the character by no means holds good in all cases, and there is no other upon which the groups can be strictly defined. The *Tenebrionidæ*, *Lagriidæ* and *Cistelidæ*, with their closed coxal cavities, may perhaps be considered a natural group, but it is obvious that several of the other Heteromerous families have very little, if any, connection with one another, and might, with better reason, be assigned to other groups, of which they are now, perhaps, merely considered the mimics.

I must now bring this address to a close: the more we study the questions involved in the general subject which we have been discussing, the more, I think, does it seem possible that several causes may have been at work to produce the evident results. There is no reason why the explanation should be the same in all cases: doubtless there are many undesigned coincidences in nature, and continuous and discontinuous variation may both be working out similar ends: there is much to be said for the gradual influence of what Dr. Dixey calls "mimetic attraction,"* and, more than many think, for sudden changes without intermediate links. The geological record is admittedly very imperfect: in fact, we have hardly done more than scratch upon its surface; but the seemingly abrupt appearance of the many elaborately perfected families of Coleoptera, without any transitional forms, appears at present to be an inexplicable problem.

I cannot conclude without saying how much pleasure it

* Trans. Ent. Soc. 1896, I. 65; 1897, III. 317.

gives me to feel that I shall be succeeded in the chair by my old and valued friend and colleague, Professor Poulton, whose work I have so often alluded to, and who has done so much in so many ways for the study of Entomology. I know that he will not agree with me in all that I have just said, but I, for one, shall look forward to his Presidential Addresses, in the hope that he may clear up many doubtful points. I feel sure that you could not choose a better man to preside over the interests of the Society and to uphold it in its present flourishing condition.

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*The Arabic figures refer to the pages of the 'Transactions'; the Roman numerals to the pages of the 'Proceedings.'*

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AM.

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Australian & Tasmanian Mordellidæ.

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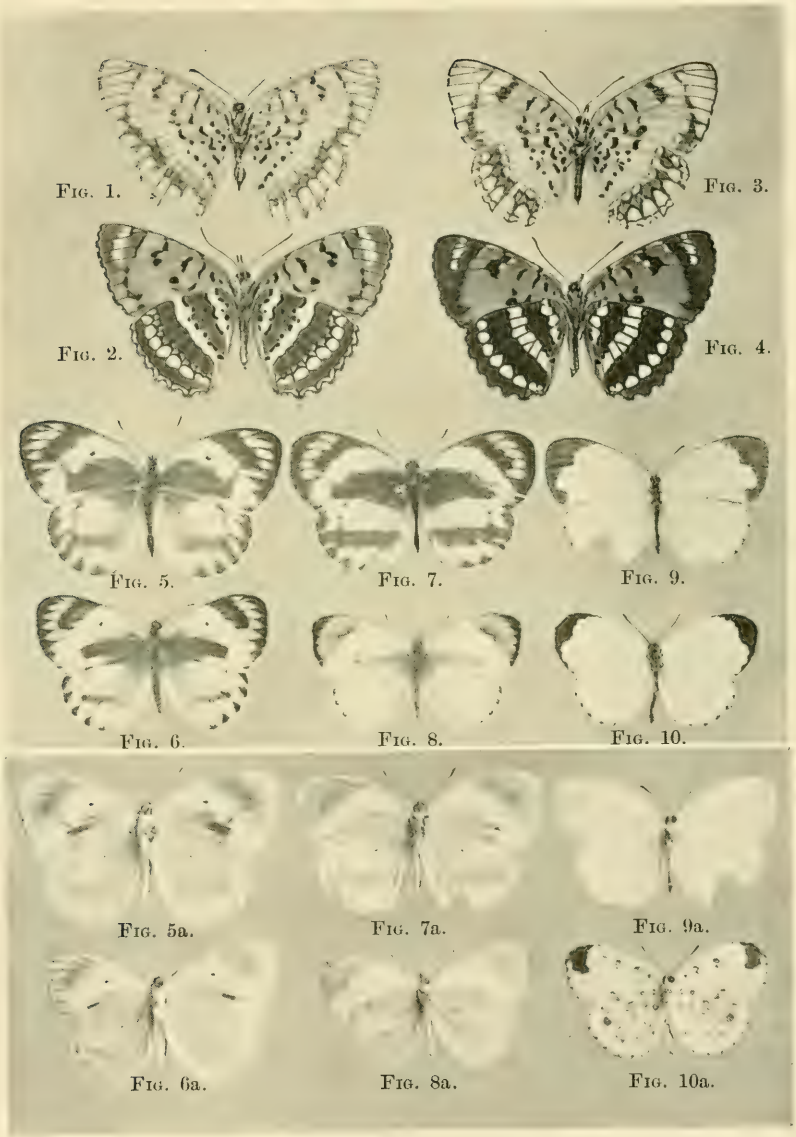

FIG. 1.

FIG. 3.

FIG. 2.

FIG. 4.

FIG. 5.

FIG. 7.

FIG. 9.

FIG. 6.

FIG. 8.

FIG. 10.

FIG. 5a.

FIG. 7a.

FIG. 9a.

FIG. 6a.

FIG. 8a.

FIG. 10a.

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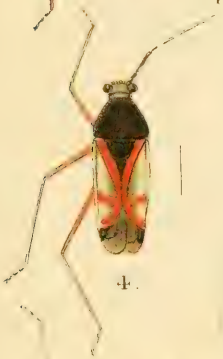

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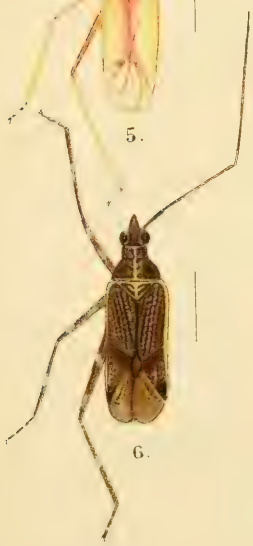

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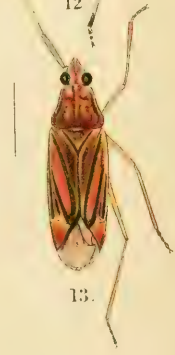

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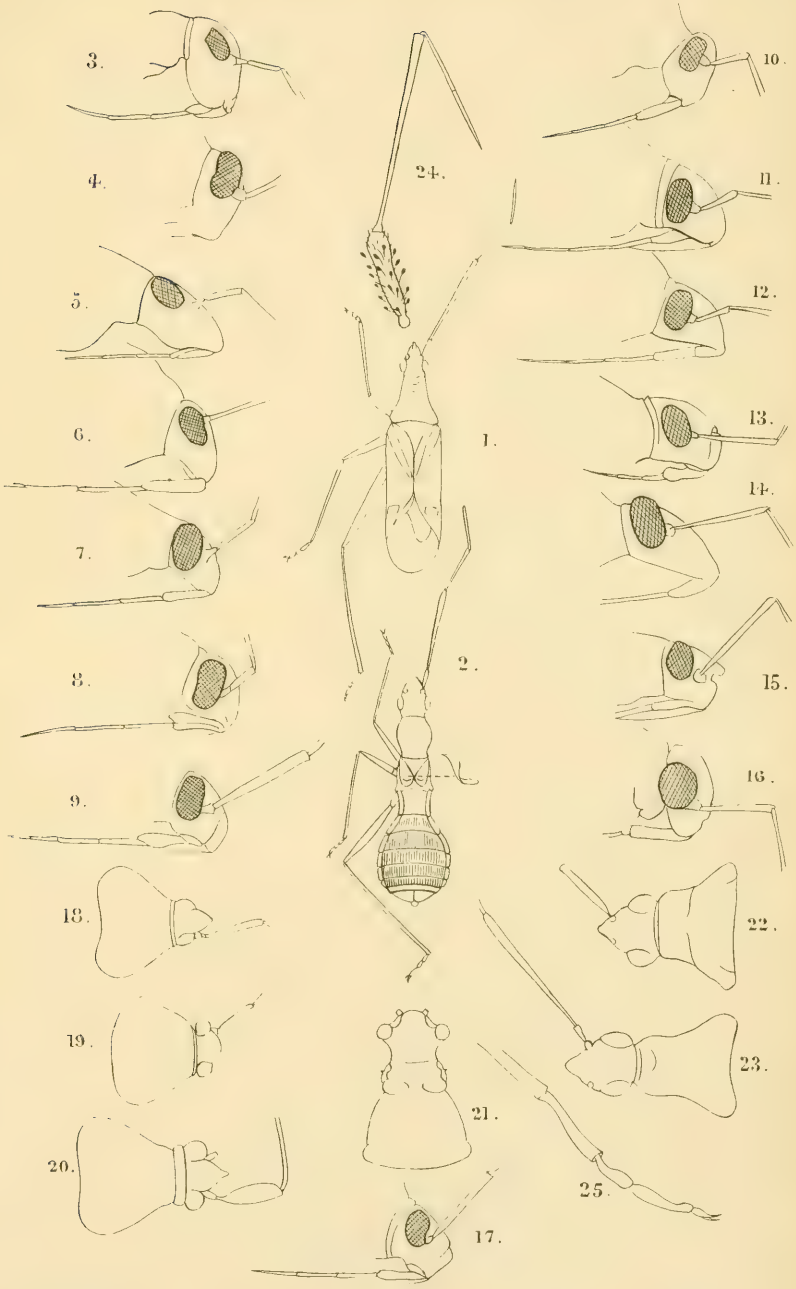
Species of Capsidæ.

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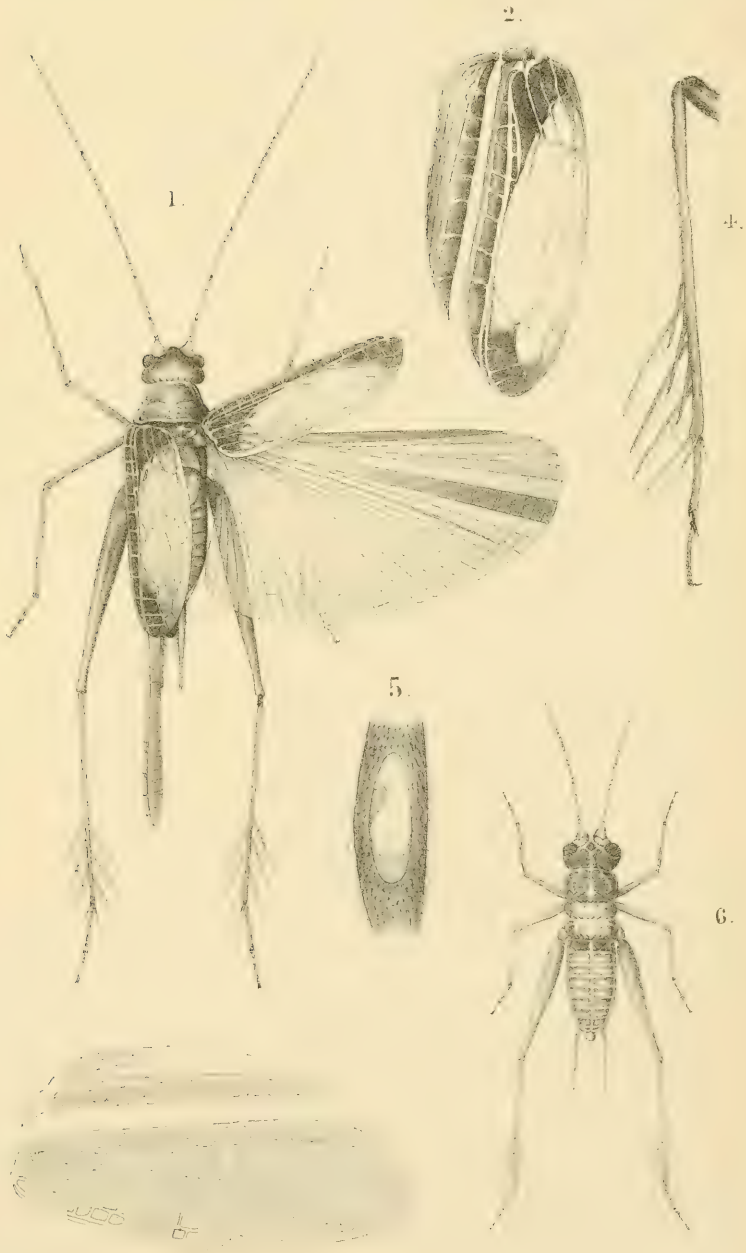
Species of Capsidæ.

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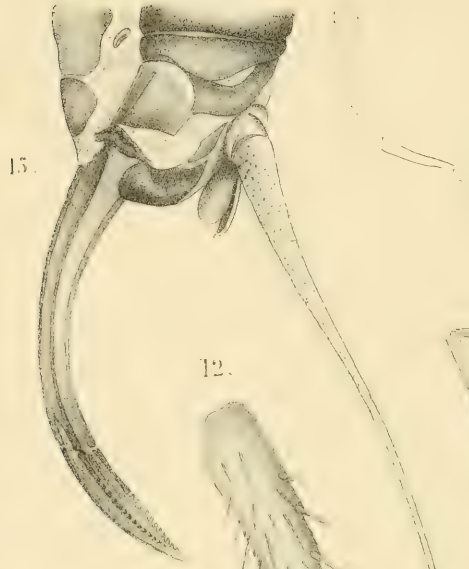
Hydropedeticus vitiensis.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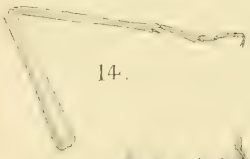
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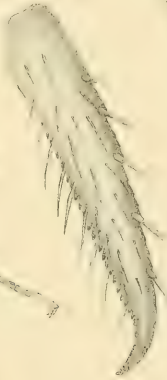

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## Injuries to Wings of South African Butterflies.

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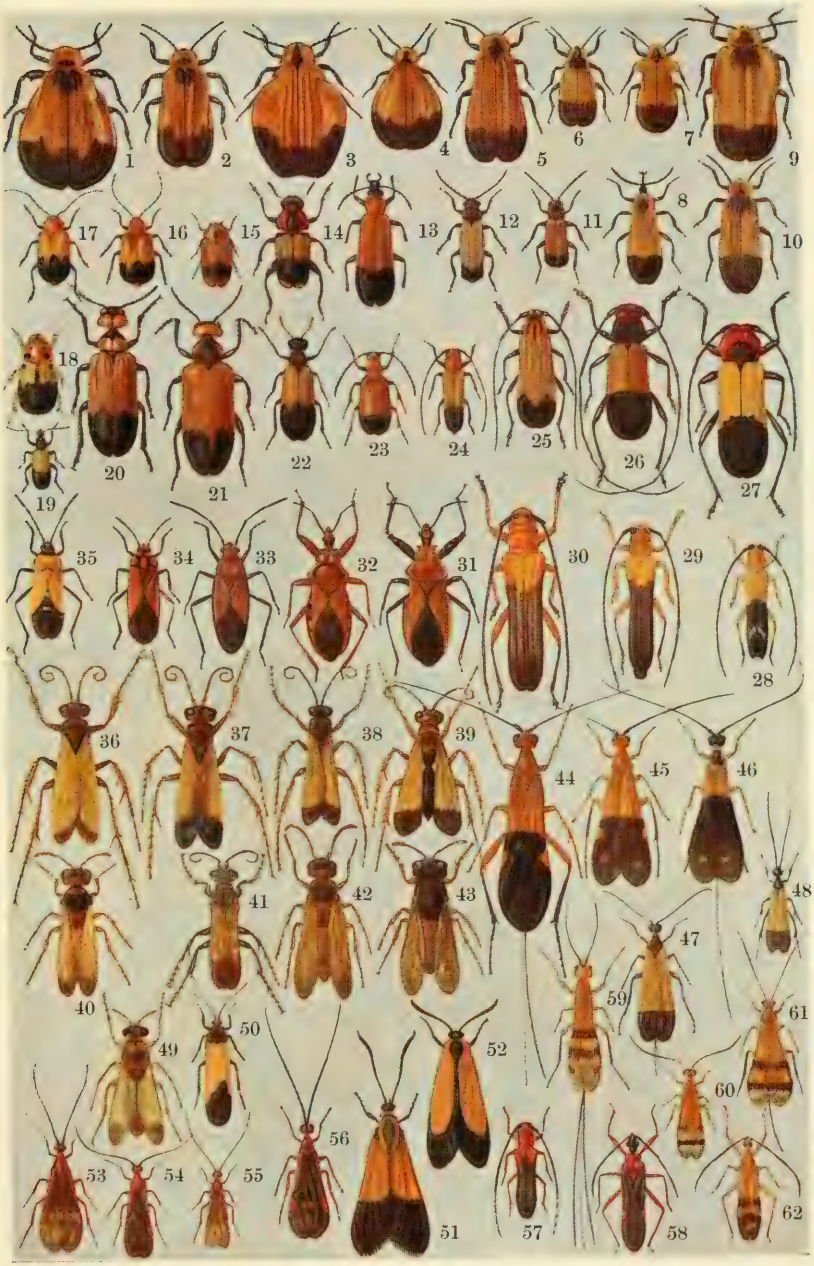


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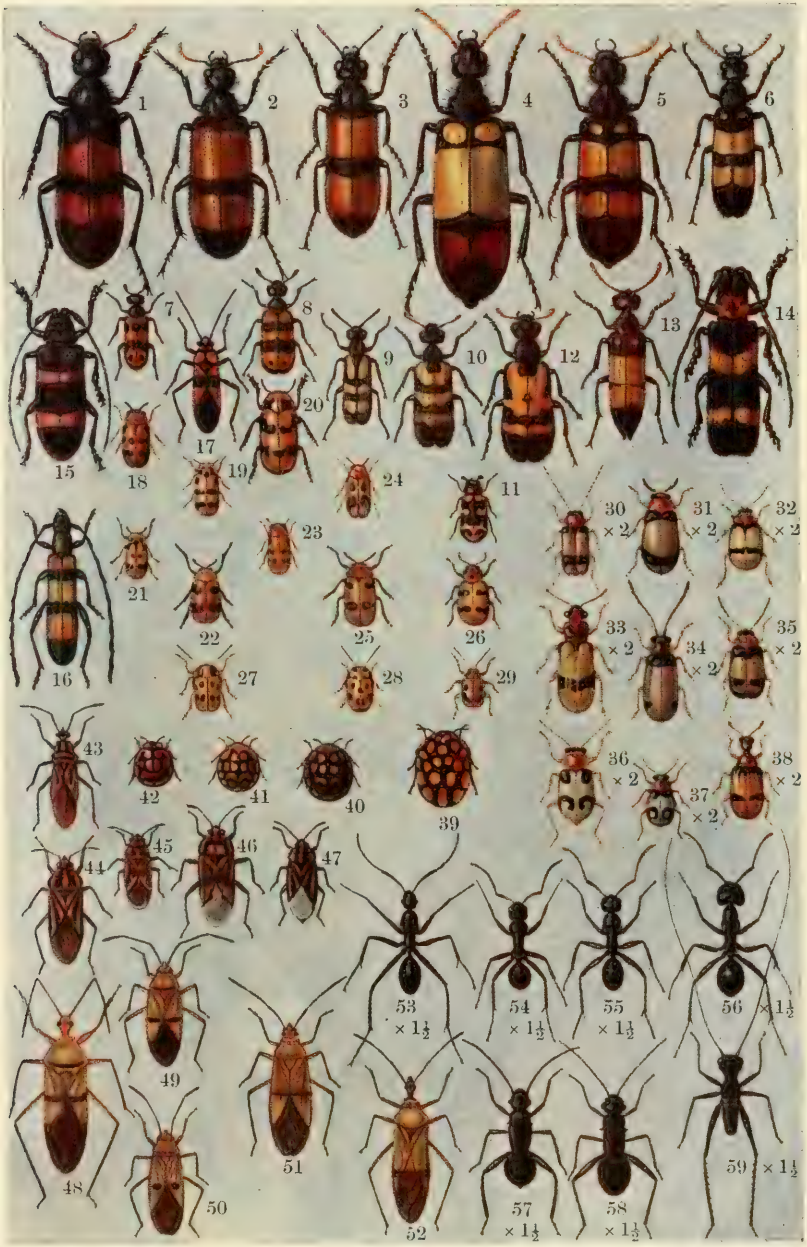


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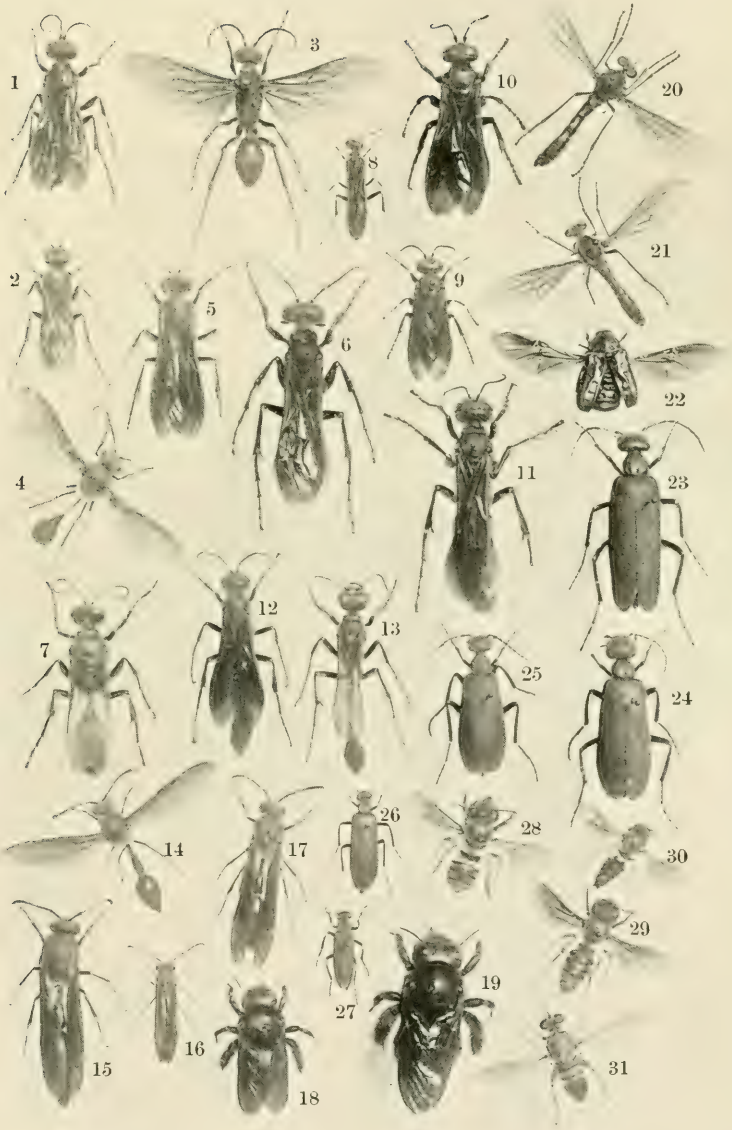
Group of black, dark-winged, Mashonaland Aculeates and their Mimics. First part of Group.

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Group of black, dark-winged Mashonaland Aculeates and their Mimics. Second part of Group.

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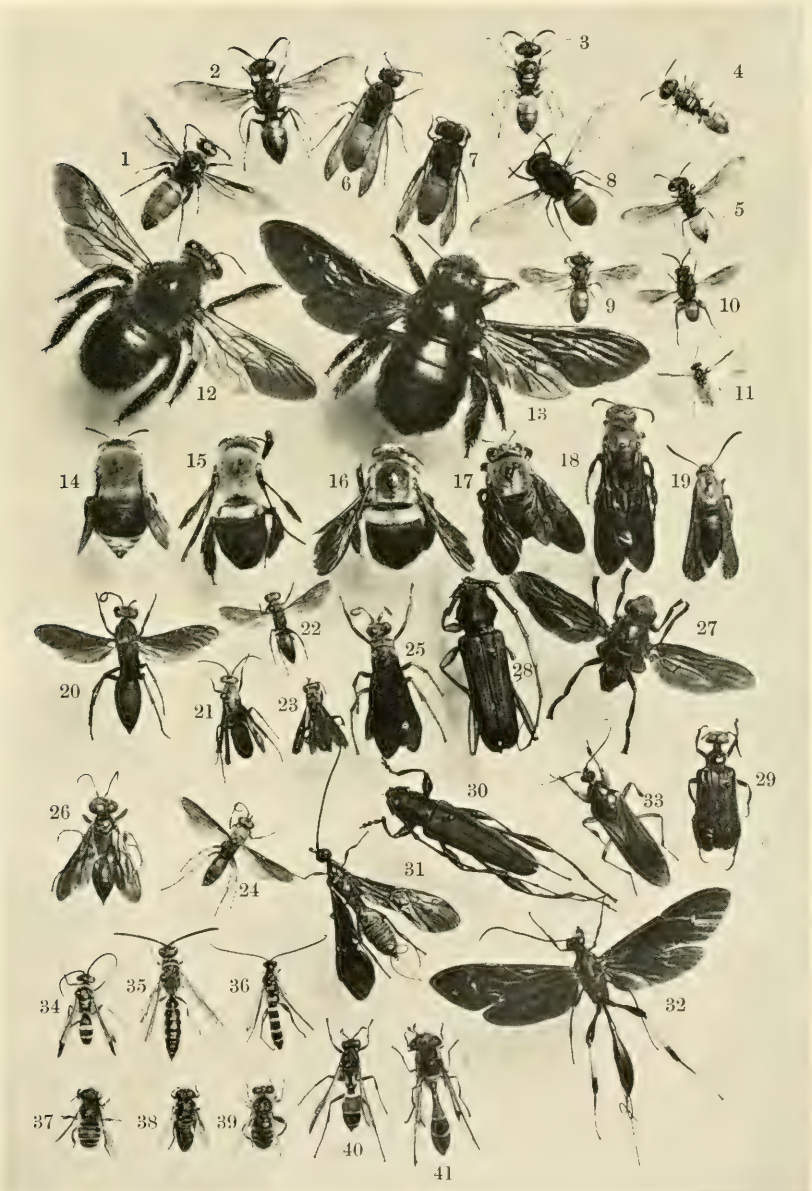
Group of yellow-tailed, black, South African Aculeates and their mimics.

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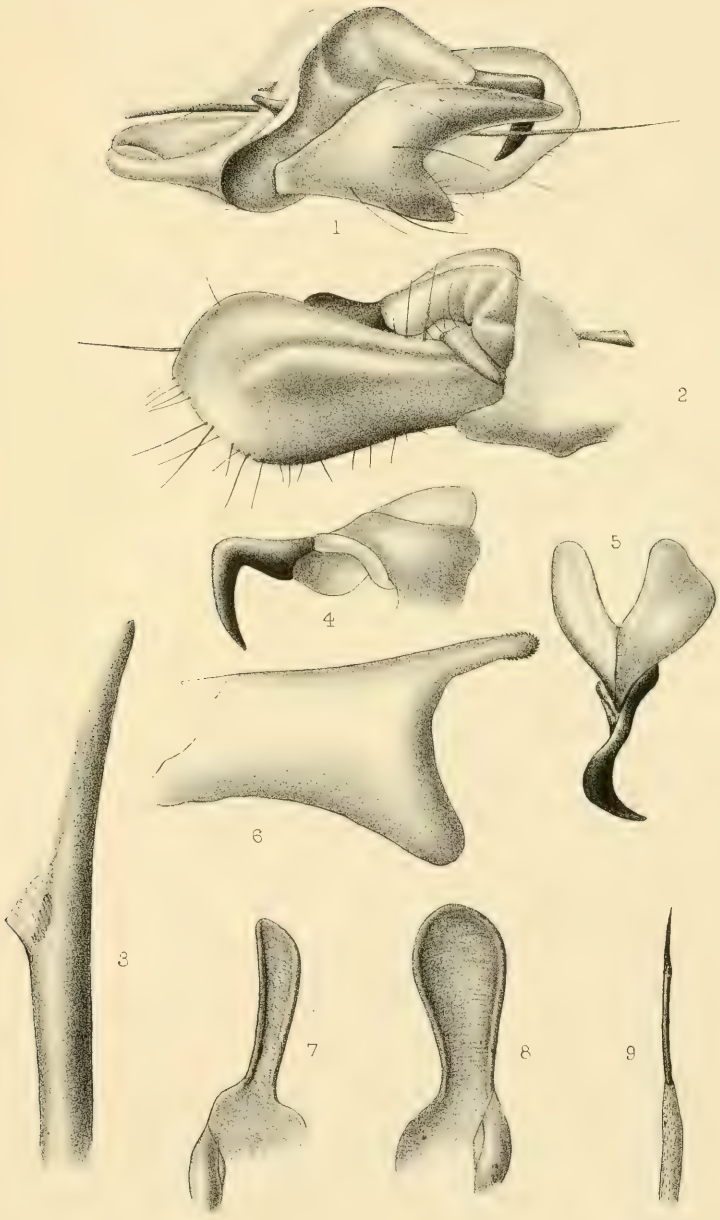
South African Aculeates and their Mimics.

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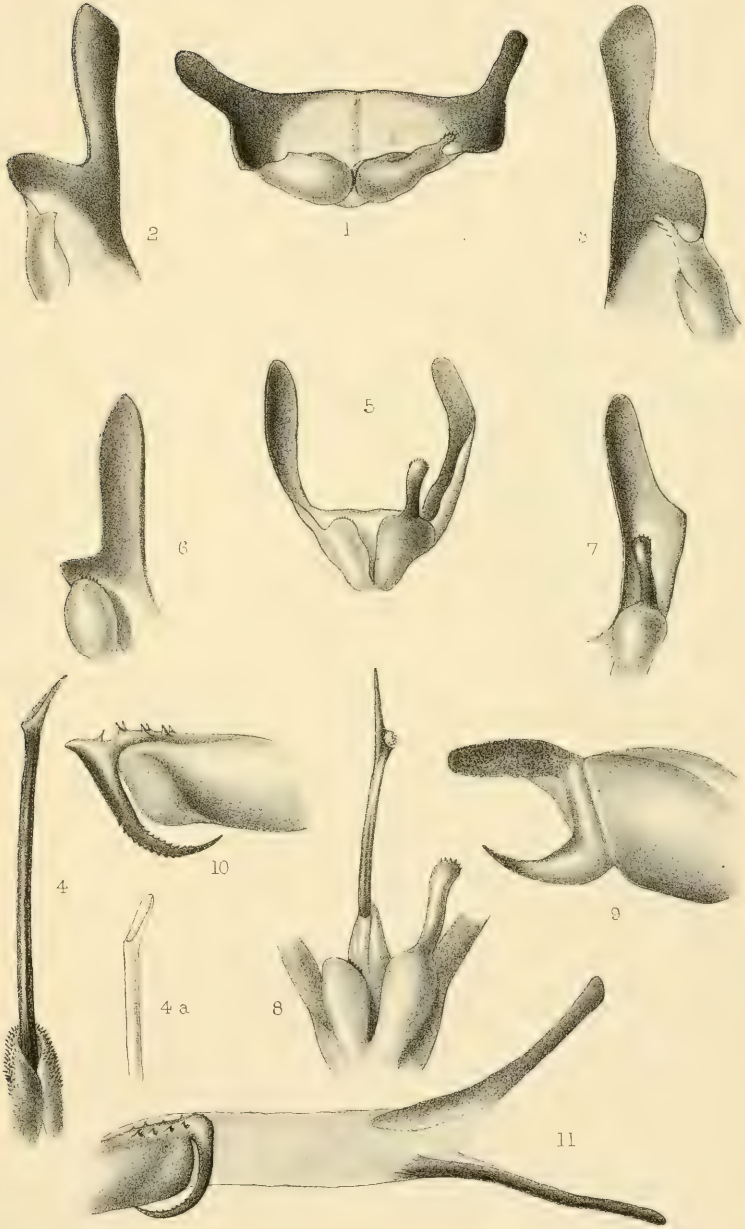
Asymmetrical appendages of Cephonodes.

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Asymmetrical appendages of Hemaris & Macroglossa

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Protective Resemblance to Flowers of British East African *Flata*. Kitui, Jan. 23, 1901.

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Larvæ of British East African *Flata.* Athi River, Jan. 20, 1901.

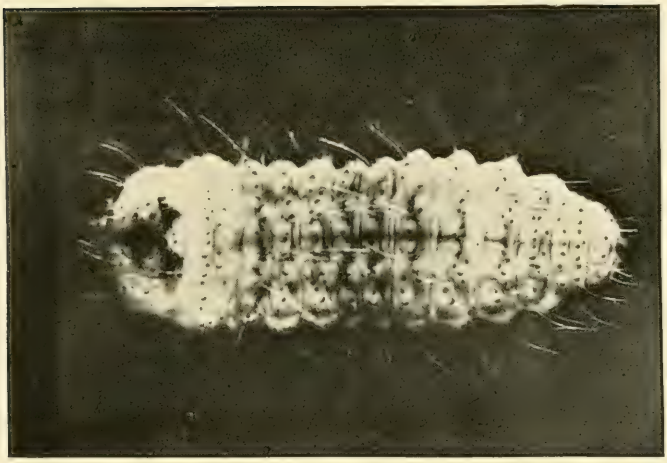

FIG. 1

3 1 2

*Mintern Brothers* FIG. 2 *R. Clay & Sons, Limited*

*Photo, F. N. Clarke*

**Larva of Heterogynis paradoxa**

(First Stage)

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